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ELEPHANTS BOND!
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Science Reporter

A CSIR PUBLICATION

Last Voyage of the Space Shuttle

Also in the issue

- Consistent Test Batsman
- GAGAN for Air Navigation
- Beyond TRIPS
- Puzzles, Quizzes, Crossword

It is Competition Time Once Again!

Science Fiction

And

Science Cartoon Competitions!

Science Reporter once again announces its 'Science Fiction and Science Cartoon Competition'. We invite *original contributions* from our readers. You may take part in any of the two competitions or even both.

In the Science Cartoon category not more than four cartoons may be sent per entrant. And remember, the cartoons should relate to scientific topics only.

In the Science Fiction category readers are requested to send only one entry per entrant. The entries must be restricted to about 2000-2500 words.

All entries—Fiction as well as Cartoon—should be original and should be accompanied with a certificate of originality.

The winning entries will be published in *Science Reporter* and winners will be paid the requisite honorarium. There is no entry fee.

Rush your entries to:

Editor, Science Reporter
Science Fiction/Science Cartoon Competition
National Institute of Science Communication And Information Resources
Dr K S Krishnan Marg
New Delhi-110 012
or
Email at sr@niscair.res.in

The last date for receiving the entries is 15 October 2011.

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NATIONAL INSTITUTE OF SCIENCE COMMUNICATION AND INFORMATION RESOURCES (NISCAIR)
COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH (CSIR)

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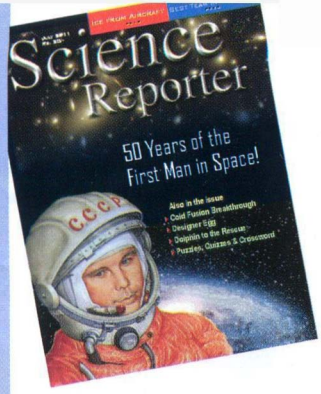

Number Two Forgotten...Always

N.S. Kumar has dwelt extensively on the build-up to Gagarin's first orbital flight (July 2011). Whereas Gagarin got all the accolades (a gold medal bearing his name was constituted in 1968, the year he died, awarded annually to spacemen for contributing towards the peaceful conquest of space and a

crater on the far side of the moon photographed by Zond-3, was also named after him), Gherman Titov, his back-up, who only four months later made a much longer space flight in Vostok-2, was left almost high and dry. He was no doubt bestowed with the Hero of the Soviet Union but that honour is given to a cosmonaut performing a successful space mission. The success of the Vostoks galvanized the United States and President Kennedy vowed to put an American on the lunar surface by the end of the decade and NASA was able to accomplish the feat on 20 July 1968.

It is ironical that those who are first in most endeavours are well remembered but the name of the second is blissfully forgotten. People know that Neil Armstrong was the first to land on the moon but few would bother to recollect Edwin Aldrin, who joined him on the lunar surface just 20 minutes later. Almost every school-kid would answer that Columbus was the first to discover America, but who was the second? We proudly recall that Rakesh Sharma was the first Indian to make an orbital flight but who was his back up?

Dr. S.K. Gurtu, Jaipur

The Spectre of Eclipses

Your July editorial **Spectacle of a Lifetime** mentions that during the last lunar eclipse there were predictions by many that it will unleash natural calamities. Like the lunar eclipse a solar eclipse creates panic on an even greater scale – the solar eclipse of 16 February 1980 did just that. Unfortunately, during and after the eclipse senseless and superfluous rites are performed. How can our children develop a scientific temper when they see their elders engaged and subscribing to absurd ritualism? Superstitions have a habit of clinging tenaciously even when convincing scientific proof to the contrary is available. As bad luck would have it, in our country a large number of people, because of their religious leanings, educated or otherwise, fall easy prey to the machinations and mumbo-jumbo of priests and astrologers.

Shashi, Indore (M.P.)

Care for the Teeth

I admired the article **Healthy Teeth for a Dazzling Smile** in the May issue. Most of us are not aware about the conditions of our teeth. Unfortunately we neglect small problems that could lead to

severe ailments in future. The column provided useful measures to sensitize us to taking more care of our teeth.

Hemochandra Sorokhaibam
Wangjing, Manipur
hemochandra2@gmail.com

II

Healthy Teeth for a Dazzling Smile (May issue) was not only an informative feature but also useful for all types of readers.

It's quite true that more or less we neglect this vital part of our body by not paying sufficient attention to the manner in which we brush our teeth. We also tend to follow the advertisements of toothpastes on TV and in newspapers instead of the advice of dentists.

Debasis Ghosh
Anandapuri, Barrackpur

Saved by SR

As a regular reader of *Science Reporter* for many years, I deeply respect this magazine. This month, just one day before salary, I and many of my colleagues got a mail from our bank that our salary account had been suspended and to fix it our account details were needed. When I got this mail, I immediately remembered the article in *Science Reporter* (May-2011), **Beware of Online Identify Thefts**. In this informative article, the authors described many methods used bank details, even constructing fake home pages of banks. I

immediately alerted my colleagues and bank. In this way I was able to save their hard earned money. I sincerely thank the authors and *Science Reporter* for this.

Dr. Vishwas B. Chavan
vishwaschavan2003@yahoo.co.in

Magnificent Magazine

In developing countries like India there are even today places where people are not aware of the wonderful advances of science. Especially, in a small town like Darjeeling District the need for more information on science is greatly felt. Your science magazine *Science Reporter* provides an excellent source of scientific information for students of the Hills. I personally would be grateful if you add more information about mathematics that is becoming uncommon amongst the Hills students.

Indira Subba
Kalimpong, Darjeeling.
sub.is69@yahoo.in

We Would Like to Hear From You

If you have any comments about any article published in *Science Reporter*, or have some information to share with our readers, do write to us at:

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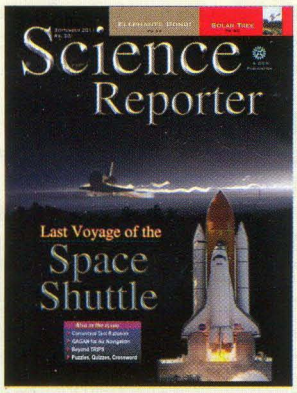
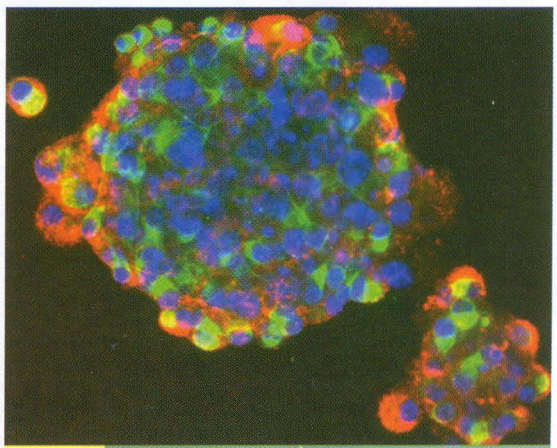


COVER DESIGN
NEERU SHARMA

STEM CELLS PUT TO TEST

More than a decade after the potential of embryonic stem cells was identified, they are being finally put to test. Dr Steven Schwartz, an eye doctor at the University of California, recently enrolled patients to test the first embryonic stem cell therapy for Stargardt's macular dystrophy and dry age-related macular degeneration (dry AMD), conditions leading to blindness and which are untreatable. According to latest reports, two of the first patients have succesfully undergone the tranpslant surgery to receive retinal pigment epithelial (RPE) cells derived from human embryonic stem cells (hESCs) and are recovering.



One of the patients had approached Dr Schwartz as a 12-year-old young girl with vision problems and had been diagnosed with Stargardt's, a common form of macular degeneration in which the light-sensing cells in the central area of vision (the macula) start to deteriorate. The cells stop working and eventually die leading to blindness. Now, as a 26-year-old young woman, she is part of the handful of other patients who are having thousands of retinal pigment epithelial cells, harnessed from human embryonic stem cells, transplanted into their eyes to substitute for the RPE cells in their retina that have been completely destroyed.

Currently both Stargardt's macular dystrophy and dry age-related macular degeneration are untreatable. Until now, the treatment option has been transplanting RPE cells in the patient's eyes before the RPE population is completely lost. But what about those whose eyes have already lost the RPE cells?

The trials hold significance and may represent a key step forward in therapeutic stem cell research, especially after all the controversy over embryonic stem cells. The harnessing of stem cells from human embryos had sparked off ethical concerns round the world. Questions were raised whether extracting cells from human embryos would not tantamount to murder as it would destroy the human embryo.

Besides, there were other questions too. Would cells harvested from embryonic stem cells grow into tumours as embryonic stem cells are known for their ability to grow indefinitely? Even if the transplanted cells do not form tumours would they be able to function as desired after transplantation into human recipients? Would they be accepted by the patient's immune system? How safe and effective such a treatment option would be? Only trials can tell.

A lot, therefore, hangs on these first trials. It has taken years to get to this point. The great promise that stem cells have been known for is ultimately being put to test. Although Dr Schwartz does not anticipate that the early patients would regain their vision completely, but once the safety of the treatment is established then scientists can do further research to figure out at what stage to intervene to get the best results. And once that happens, it could throw open a viable treatment option for several debilitating conditions.

Hasan Jawaid Khan

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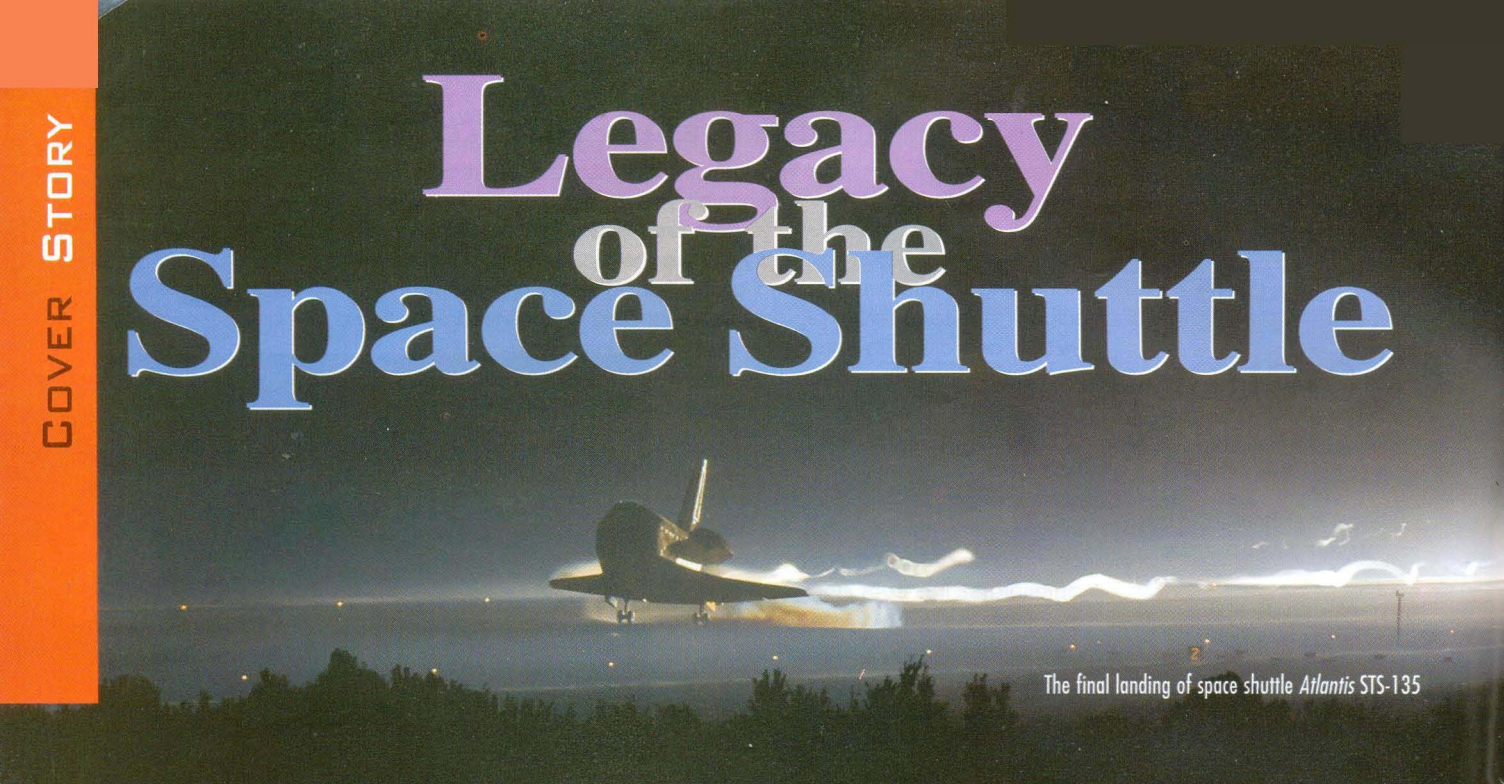
Legacy of the Space Shuttle



The final landing of space shuttle *Atlantis* STS-135

21 July 2011 marked the end of an era—the era of the Space Shuttle. During the three decades of its existence, the Space Shuttle helped build the largest space station in history, revolutionized science with the launch of missions like the Hubble Space Telescope, and inspired generations who dreamt of riding the shuttle into the sky.

SAKET SINGH KAURAV

WHEN Space Shuttle *Atlantis* touched down in the early morning hours of 21 July 2011, concluding the history-making 13-day flight to the International Space Station and back, it signalled the end of an era. The 30-year space shuttle programme, which began with the launch of Columbia on 12 April 1981, had drawn to a close. The space shuttle, the world's first reusable spacecraft that can carry large satellites both to and from orbit, had truly retired from service.

The shuttle launches like a rocket, manoeuvres in Earth orbit like a spacecraft and lands like an airplane. The journey of the space shuttle concept began near the end of the Apollo space programme when NASA had been looking to bolster its space programme. They were using one-shot, disposable rockets. What they needed was a reliable, less expensive rocket, perhaps one that was reusable. The idea of a reusable "space shuttle" that could launch like a rocket but land like an airplane was appealing and a great technical achievement.

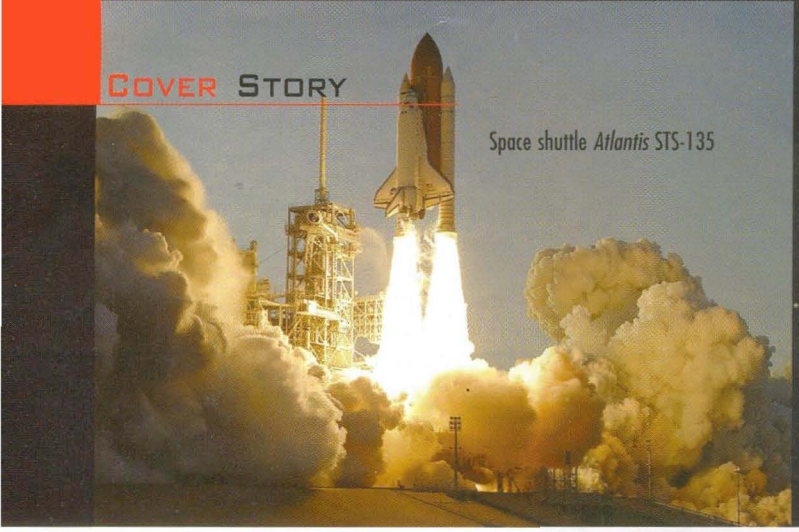
The space shuttle made valuable contributions in the field of Space Science and Technology. According to NASA, some innovative ideas from this programme made our lives safer such as the fiber optic forceps, lightning detectors, thermal protectors, and 3-D graphic tools for special effects. NASA retired the space shuttle missions with the farewell mission *Atlantis-135*, which landed safely on 21 July 2011. During the STS-135 mission *Atlantis* orbited the Earth 200 times and journeyed 5,284,862 miles.

This was an unforgettable farewell to any space mission since 1969 after the Apollo mission. Over the 30 years of its history, the space shuttle has had an indelible impact on America. The United States' spaceship of choice for three decades helped build the largest space station in history, revolutionized science with the launch of mission like the Hubble Space Telescope, and inspired generations who dreamed of riding the shuttle into the sky.

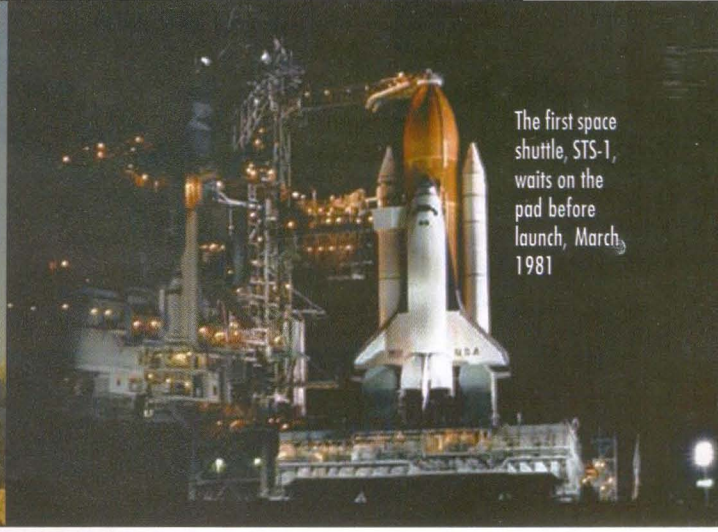
Back in Time

Though design and construction of the Space Shuttle began in the early 1970s, conceptualization began two decades earlier, before the Apollo programme of the 1960s. The concept of a spacecraft returning from space to a horizontal landing began within NACA (National Advisory Committee for Aeronautics) in 1954, in the form of an aeronautics research experiment. There were many brainstorming researches and meetings until the final design for reusable space vehicles could be conceptualized.

During early shuttle development there was great debate about the optimal shuttle design that best balanced capability, development cost and operating cost. Ultimately the current design was chosen, using a reusable winged orbiter, solid rocket boosters, and expendable external tank.



Space shuttle *Atlantis* STS-135



The first space shuttle, STS-1, waits on the pad before launch, March 1981

The shuttle programme was formally launched on 5 January 1972, when President Nixon announced that NASA would proceed with the development of a reusable Space Shuttle system. The final design was less costly to build and less technically ambitious than earlier fully reusable designs.

The first fully functional Shuttle Orbiter was the *Columbia*. It was delivered to Kennedy Space Centre on 25 March 1979, and was first launched on 12 April 1981—the 20th anniversary of Yuri Gagarin's space flight—with a crew of two. *Challenger* was delivered to KSC in July 1982, *Discovery* in November 1983, and *Atlantis* in April 1985. *Challenger* was destroyed when it disintegrated during ascent on 28 January 1986, with the loss of all seven astronauts on board, one of them the first teacher in space—Christa McAuliffe. *Endeavour* was built to replace her (using spare parts originally intended for the other Orbiters) and delivered in May 1991; it was launched a year later. Seventeen years after *Challenger*, *Columbia* was destroyed during re-entry on 1 February 2003, killing all its seven crew members, including Kalpana Chawla; it has not been replaced. These disasters shook NASA and the space industry, as well as the world as a whole. But both times the space shuttle programme stoppe accidents, then regrouped to come back stronger than before.

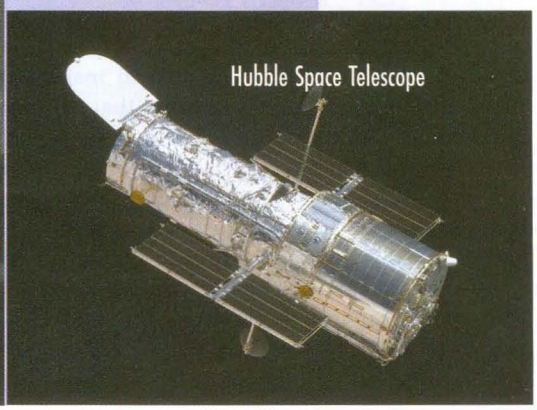
DID YOU KNOW?

- **The first space shuttle flew in 1981.**
- **Including the STS-135 mission, the total number of space shuttle launches is 135.**
- **Five space shuttles have flown: *Columbia*, *Discovery*, *Challenger*, *Endeavour* and *Atlantis*.**
- **The space shuttle system is made up of the orbiter, two solid rocket boosters and the external tank.**
- **The orbiter travels in space at 17,500 miles (28,163 km) per hour.**

Amazing Flying Machine

When it first arrived on the scene in 1981, the space shuttle was revolutionary. It was the first launch vehicle to lift off like a rocket, orbit the Earth as a spacecraft and then land as a glider. The space shuttle was also the world's first reusable crewed orbital spacecraft. The space shuttle has been integral to many of the most impressive space achievements over the last three decades. This is the hugest, biggest piece of space hardware that human beings have ever built.

President Nixon (right) with NASA Administrator Fletcher in January 1972, three months before Congress approved funding for the shuttle programme



Hubble Space Telescope

Many space missions could become possible because of the space shuttle's incredible power and space availability in its bay.

STS-135 crew members
(Photo credit NASA)

The space shuttle was made to take astronauts and cargo to and from Earth orbit. The space shuttle normally takes as many as seven astronauts to and from space. It has the largest cargo-carrying capacity of any spaceship flying today and has delivered most of the biggest man-made objects to space. It takes people and parts up to space, and then it comes back and gears up for another mission.

In addition to delivering space hardware for assembly, the shuttle has brought people together. One of the biggest contributions of the space shuttle programme is building an International Space Station (ISS) in Space. ISS was possible only because of the space shuttle. The International Space Station is a great manmade endeavour in space. It is an orbiting laboratory in space for conducting research in micro gravity. ISS is a combination of many pieces of different laboratories, each one huge in

FIRST iPHONE ON LAST SHUTTLE

The crew of the space shuttle Atlantis' STS-135 mission took the first iPhone into space to help with experiments aboard the International Space Station. A Houston company called Odyssey Space Research developed an application for the Apple smartphone that was meant to help the astronauts track their scientific results and perhaps one day aid navigation. The application, called SpaceLab for iOS, is even available to Earthbound smartphone users to perform the same experiments with the software simulating microgravity. According to the company, the software was designed with the iPhone's unique attributes in mind, such as the gyro, accelerometer, cameras and chip.

Along with the first iPhone, the crew of Atlantis also took with them numerous items commemorating the final mission of the space shuttle programme. For instance, a flag from the first shuttle flight in 1981 was carried to the station and left there until the first commercial spaceflight to the station, when NASA astronauts will retrieve it. The astronauts, Commander Chris Ferguson, Pilot Doug Hurley and Mission Specialists Sandy Magnus and Rex Walheim, allocated a number of unique items that will become commemoratives for numerous organizations after they return to Earth.

For example, American flags from the Delaware Valley Historic Aircraft Association, Key Peninsula Middle School in Lake Bay, Washington, and a fire station in Houston are to orbit the Earth for 12 days before being handed over to their sponsors as symbols of inspiration.

The U.S. Honour Flag also flew aboard Atlantis. Begun as a tribute following the 11 September 2001 terrorists' attacks, the American flag serves as a travelling memorial to heroes who lost their lives while serving their communities and country.

Among the unusual things headed into space was a recipe card from one of the dishes served at Astronaut Crew Quarters at NASA's Kennedy Space Center in Florida.

NASCAR is well represented on the mission with a cap from Joe Gibbs Racing and black flags from Texas Motor Speedway and the NASCAR organization on the roster of items.

More than 500 STS-135 mission patches are tucked inside Atlantis for the flight, a common take-along for all shuttle missions, along with 800 small American flags that typically are handed out after a mission as awards and recognitions. After the return of the crew, the items will be unpacked from lockers inside the shuttle and returned to the astronauts who often make personal visits to hand them back to their owners. The custom of carrying mementoes into space began in the days of the Mercury missions, when an astronaut would take a roll of coins or some other small tokens into space. The Apollo astronauts carried items to the moon and back during their missions.

The tradition is not expected to end with the end of the shuttle programme. When SpaceX launched its Dragon capsule last year, for instance, it carried commemorative items inside, most notably a wedge of cheese. The items taken and returned from space rest in schools, museums and facilities all over the world and are often prominently displayed to inspire people to think of the adventures they might one day take themselves.

Courtesy NASA

Shuttle during liftoff

Shuttle on launch pad

A substitute for the space shuttle is not a single nation's dream; it is a common dream for all space technology-enabled nations

The design and construction of the Space Shuttle began in the early 1970s.

STS-135 MISSION STATISTICS

Landed:
Thursday, 21 July 2011, 5:57 a.m. EDT

Landing Site:
Kennedy Space Center, Florida

Mission Elapsed Time:
12 days, 18 hours, 28 minutes, 50 seconds

Total miles:
More than 5.2 million

size. One after the other, the space shuttles carried with them these huge laboratories into space where waiting astronauts assembled them with the help of Space Walks.

The shuttle also launched the Hubble Space Telescope, which has offered humanity an unprecedented view of the cosmos and reshaped our understanding of the Universe. When the observatory initially produced blurry images because of a fault in its mirror, astronauts aboard the space shuttle made a nail-biting repair visit to fix the optics. This was the first repairing mission in the history of space. It was made possible because of this great space vehicle.

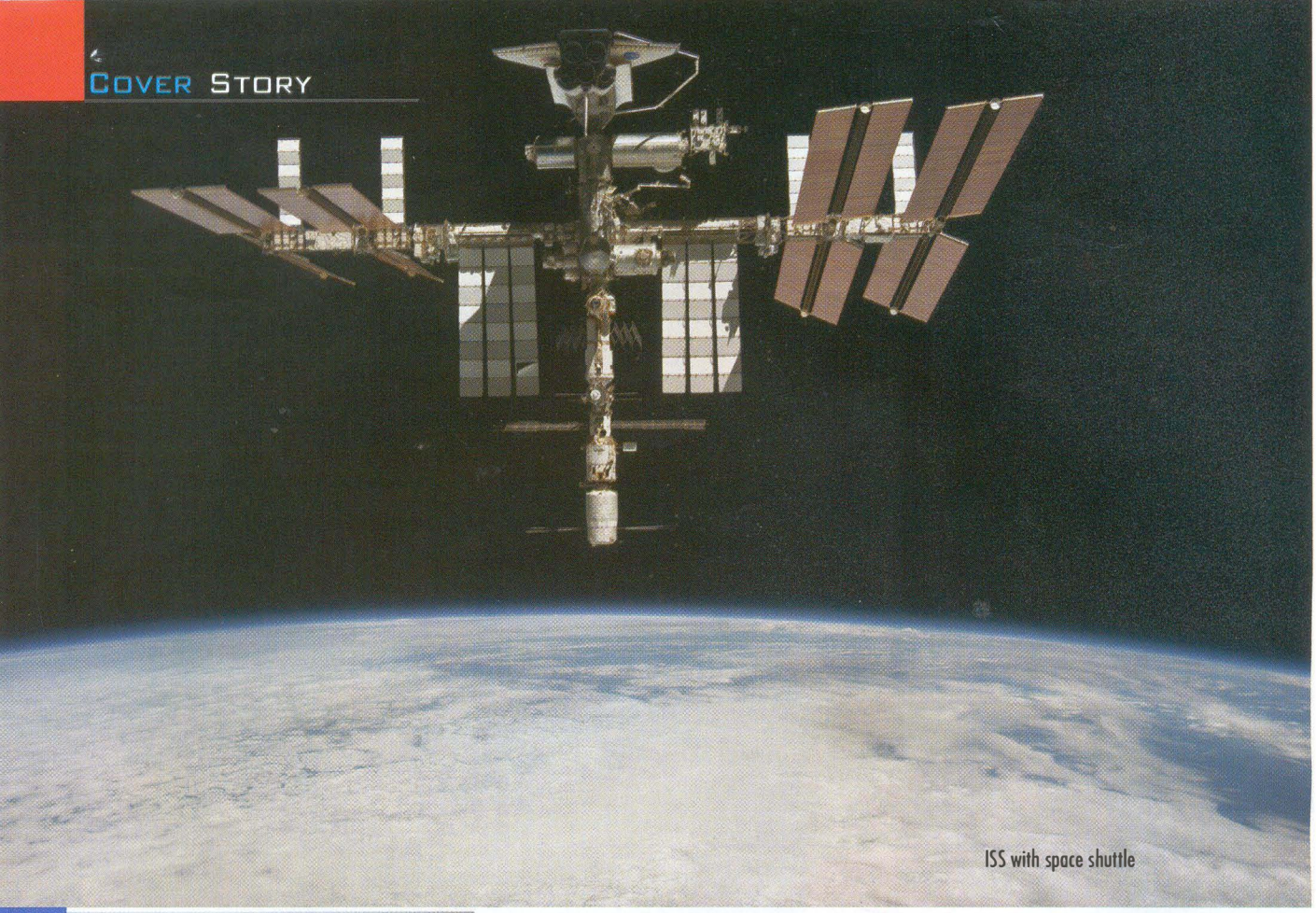
The space shuttle has three main parts. The first part is the orbiter. The orbiter is the large, white space plane. It is the only part of the shuttle that goes into orbit. The orbiter is where the crew members live and work. It also has a payload bay for taking cargo into orbit. The second part of the shuttle is the external tank. This large, orange fuel tank connects to the bottom of the orbiter for launch. The third part is really two pieces. Two white solid rocket boosters send out most of the thrust for the first two minutes of a shuttle launch. The solid rocket boosters are long and thin.

The space shuttle takes off like a rocket. The solid rocket boosters and the main engines on the orbiter provide the thrust for launch. The solid rocket boosters burn for about two minutes. Then they are dropped from the shuttle and fall into the ocean. Special boats bring them back so they can be used again.

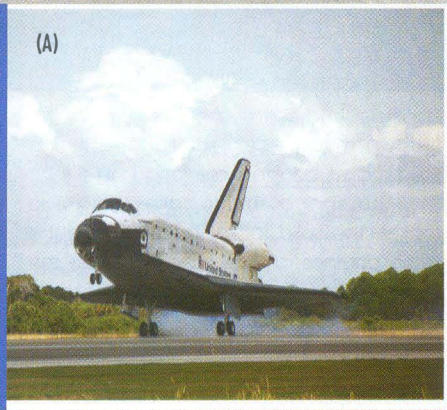
The shuttle's main engines fire for about another six minutes. The external tank is dropped when all the fuel has been used. Shortly after this happens the shuttle and crew are in orbit. The orbiter lands like a glider. While in orbit it fires its engines to slow down and stop orbiting. After it re-enters Earth's atmosphere, it glides in for a landing on a runway.

The Inspiring Shuttles

Space exploration is a very exciting field of research for all space technology-enabled countries. Human space flight still needs most reliable and safe solutions for further inter-planetary missions. The three decades of the journey of space shuttles



ISS with space shuttle



(A)

(B)

Shuttle during landing (A)

After completing the STS-135 mission (B)

NASA retired the space shuttle missions with the farewell mission *Atlantis-135*, which landed safely on 21 July 2011. During the STS-135 mission *Atlantis* orbited the Earth 200 times and journeyed 5,284,862 miles.

is a most important milestone for space technology and this will always motivate the younger generation to take up challenges for the benefit of Mankind. To inspire the younger generation, NASA has decided to donate the three remaining space shuttles to three American Science Museums. This is a great gift for any science museum to have—a real space vehicle on display! It will inspire the young generations to work hard for the benefit of Mankind.

The space shuttles contributed a lot to the development of space science and technology through their non-stop flights from Earth to space. Many space missions could become possible because of the space shuttle's incredible power and space availability in its bay. The great engineering feat, which revolutionized space technology, will always inspire and motivate the next generation to develop a powerful reusable and very cheap space transportation vehicle for the future space missions for Moon, Mars and beyond.

What after the space shuttles? Replacement of the space shuttle is opening up many challenging opportunities for scientists and engineers to develop new generation space transportation systems for continued space exploration. The retirement of the space shuttle has given a boost to the healthy competition among private space industries to come-up with advances and reliable space vehicle solutions.

A substitute for the space shuttle is not a single nation's dream; it is a common dream for all space technology-enabled nations to explore the cosmos deeper and deeper.

Mr Saket Singh Kaurav is Curator at National Council of Science Museums (NCSM), Block-GN, Sector-V, Salt Lake City, Kolkata-700091; http://cosmosvoyage.blogspot.com/

GAGAN
A New Dimension in Aircraft Navigation

M.S.S. MURTHY AND K.N. SURYANARAYANA RAO

In the coming years pilots flying over the Indian air space need no longer depend solely upon the conventional ground-based radar systems for receiving navigational instructions. They will be guided by a more accurate and seamless satellite-based navigation system to be installed jointly by the Indian Space Research Organization (ISRO) and the Airports Authority of India (AAI).

Presently, air traffic management over the Indian sky is carried out with the aid of ground-based radar sites. The aircraft has to pass over these sites, which form "highways in the sky", to receive navigational instructions via radio signals on the position, speed, altitude, route, etc. With increasing air traffic, these highways become congested, slowing down traffic movement. Radar control also restricts air route availability. Further, dissimilar procedures and standards from airport to airport result in changes in flight profiles at the boundaries. In case of congestion, the system cannot provide alternative route structures to the pilots.

With the satellite-based navigation system, the pilot is provided with on-board position for precision and non-precision landing approaches as well as for *en route* applications. This will result in the opening up of air connections to a large number of small Airports that lack the conventional full-fledged navigational facilities.

The basic requirement for a satellite-based navigation system is a constellation of satellites with known orbits, which can be used as reference. Satellite-based navigation system is not new. The US government launched a satellite constellation known as Global Positioning System (GPS) in the 1980s for use by the military. It is also available for civilian use. World over, rail, road and ocean traffic and even individuals have been using it to know their exact position anywhere on the globe and also to chart out the route for their destination.

The International Civil Aviation Organization (ICAO) has endorsed GPS as the core satellite constellation to provide worldwide seamless navigation for c aviation.

What is GPS?

GPS consists of three main segments: 1) the satellite constellation, 2) the ground control network and 3) the user equipment.

The satellite constellation is made up of 30 solar-powered satellites, which revolve around the earth in six orbital planes at a radius of about 26,600 km from the center of the earth. Their main function is to continually broadcast ranging and navigational signals. These are in the form of pseudo random codes (PRC), transmitted as low power radio waves in the L band carrying information on their position in space and time. Each satellite is identified with a unique PRN code and equipped with an atomic clock for precise timing.

The ground control network consists of six stations across the globe. They constantly monitor the satellites for their health and fine-tune their orbital data, which is transmitted back to them.

The user equipment is a GPS receiver. It captures the ranging and navigational signals from the satellites in view and computes the user's position (latitude, longitude and altitude), velocity and time (PVT). Any one with a suitable GPS receiver—an individual hiker, a vehicle on road, a ship or an aircraft---can receive the signals for navigation purposes.

The position accuracy of the GPS is about 20 and 30 meters in the horizontal and vertical directions respectively. Though this may be adequate for ocean and road transport navigation, aircraft navigation requires much greater accuracy. For example, the ICAO stipulates that the navigation system should provide a horizontal and vertical position accuracy of 16 meters and 6 meters respectively. The integrity or the correctness of the information should be 1 to 2 X 10^{-7} which means correct to more than one out of ten million times. It should quickly alert the receiver within 6 seconds, if the navigation system is out of tolerance and cannot be used. It should also be capable of continuous operation without interruption.

Sources of Error

Thus, the accuracy and integrity of the GPS is not sufficient for air traffic management and navigation, particularly during precision approach. Inaccuracies arise from several sources such as the ionosphere, drift in the satellite orbits (ephemeris), clock drift and signal degradation. These have to be corrected in order to augment the GPS signals to make them suitable for civil aviation navigation.

Ionospheric correction: The upper part of the atmosphere, from about 85 km to 1000 km from the surface of the Earth, is called ionosphere. Here, solar radiation ionizes air molecules by knocking out electrons out of them. This layer of ionized air has important practical applications. It makes possible the propagation of radio waves to distant places on the globe. However, electrons in the ionosphere scatter the GPS signals as they pass through the ionosphere, causing delay in their passage. Since position determination is based on the time taken by the signal to travel from the satellite to the GPS receiver, this delay introduces inaccuracies in range calculations.

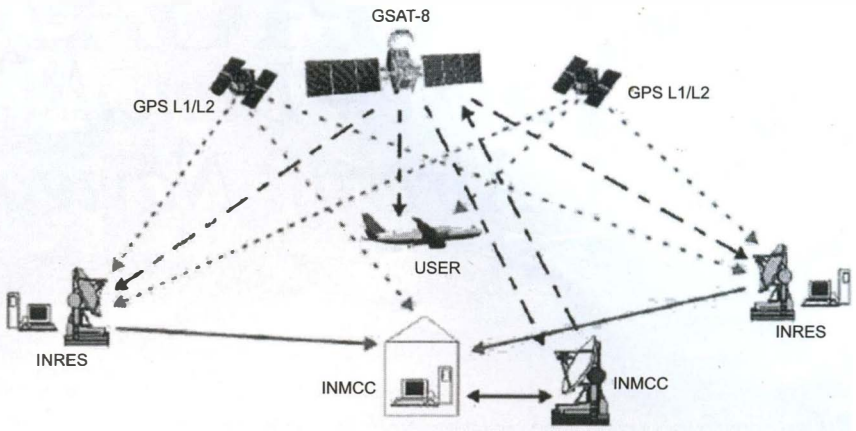
The extent of delay in signal transmission is not the same at all locations on earth at all times. This is because the ionization in the ionosphere varies with a number of factors like the time of the day, the season, and solar activity. It also depends upon the geographical location such as poles, auroral zones, mid-latitudes, and equatorial regions. India is situated near the equator where the ionospheric variation is very high resulting in range inaccuracies of the order of 25 to 50 m.

This can be corrected by suitably modeling the ionosphere over the Indian airspace. To do this, a grid of 25 ground-based ionospheric reference stations, separated by 500 km, has been set up across the country. Each station is equipped with a dual frequency GPS receiver, which collects raw pseudorange measurements from all the visible satellites. These are then converted to what are known as 'total electron content' in the ionosphere and further analyzed to generate a suitable ionospheric model to determine the signal delay over the Indian sky.

The Indian team at ISRO has been successful in the development of the region specific Ionospheric model for the region. The implementation of this model along with the modification of the Grid Ionospheric Vertical Error confidence steps at the grid points is expected to provide the required performance levels. This effort in the Final Operational Phase is very creditable and will bring to focus our achievements in the area. It should be noted that this is a very difficult task given the various International standards to be adhered to, the need to be backward compatible and the vigorous testing and the certification process that is involved.

Ephemeris correction: The orbital positions of the satellites change due to natural phenomena such as gravitational force from the Sun and moon and due to pressure from solar winds. It is necessary to know the exact positions of the satellites for accurate range measurement. The order of precision required is several orders higher for Navigation Satellites than what is required for other applications. This is achieved through the use of precision ranging using the radio frequency signals as well as laser. There is always some error introduced due to the difference in the actual Ephemeris and the estimated one. This introduces some error in the location.

GAGAN Concept



An interesting aspect of the project is the name chosen for this system, which is strikingly Indian. It is called GAGAN (*G*PS *A*ided *G*EO *A*ugmented *N*avigation).

Clock drift correction: Highly stable Atomic Clocks are used in the Navigation Satellites for ensuring precision in the position accuracy. Even then, the minute drift of the onboard Atomic Clock introduces errors. Fortunately the errors are systematic in nature and it is possible to correct it to a large extent.

Multiple path correction: The signals coming from the satellites may also undergo multiple reflections and diffractions by objects like mountains, water bodies, tall buildings, etc on their path. This leads to degradation in their quality resulting in errors in range measurements. The error can be reduced by suitable choice of antennae and receivers.

GAGAN

The ISRO and the AAI signed a MoU to install a space-based augmentation system (SBAS) to render the GPS signal suitable for civil aviation over the Indian airspace. An interesting aspect of the project is the name chosen for this system, which is strikingly Indian. It is called GAGAN (*G*PS *A*ided *G*EO *A*ugmented *N*avigation).

As with GPS, SBAS also consists of three segments: the space segment, the ground segment and the user segment.

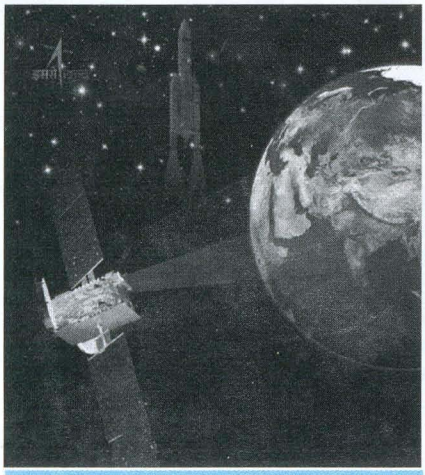
The space segment of GAGAN consists of three geosynchronous communication satellites. The first one, GSAT-8, was launched by ISRO on 21 May 2011 from Kourou, French Guiana. The satellite, weighing about 3100 kg, has been positioned in a geostationary orbit at 55-degree east longitude on the Indian Ocean. It carries a dual frequency L1 and L5 navigation payload compatible with the GPS. Since a minimum of three satellites are required to meet the availability specifications applicable for civil aviation, two more satellites will be added in due course.

The ground segment consists of 15 Indian Reference Stations (INRESs), an Indian Master Control Center (INMCC) and an Indian Navigation Land Uplink Station (INLUS), all suitably augmented. In the Final Operational Phase, which is currently being carried out, the Reference Stations are located at Ahmedabad, Bangalore, Thiruvananthapuram, Port Blair, Delhi, Kolkata, Guwahati, Jammu, Dibrugarh, Patna, Bhubaneshwar, Nagpur, Goa, Porbandar and Jaisalmer. They are connected to the INMCC at Bangalore. Each station is provided with a minimum of two identical GPS receivers/antennae subsystems to receive GPS signals.

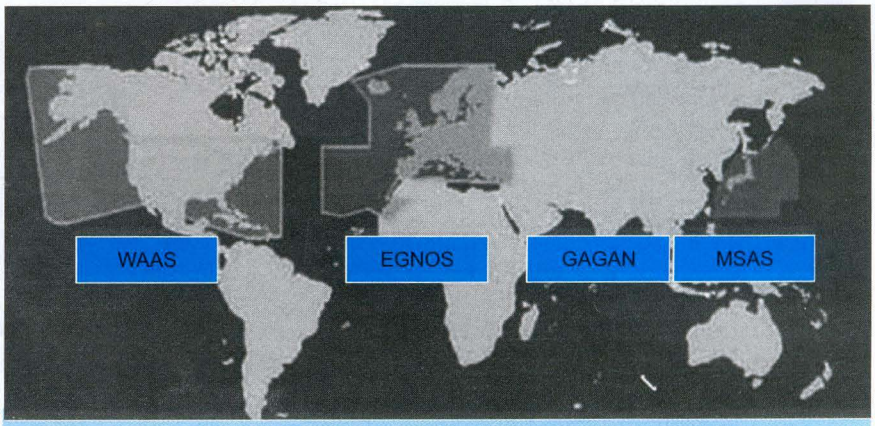
The INMCC processes the data received from all the 15 INRESs. It will also estimate the integrity and the availability of the GPS satellites and transmits the corrections and confidence parameters to the INLUS.

The INLUS, also located at Bangalore, formats these messages consisting of ionospheric, ephemeris and clock drift corrections and transmits them to the satellites' navigation payload for broadcasting to the user segment.

The user segment is a modified GPS receiver installed in the aircraft. It receives these signals and determines the aircraft's



GSAT-B with GAGAN Payload beaming on Indian air space

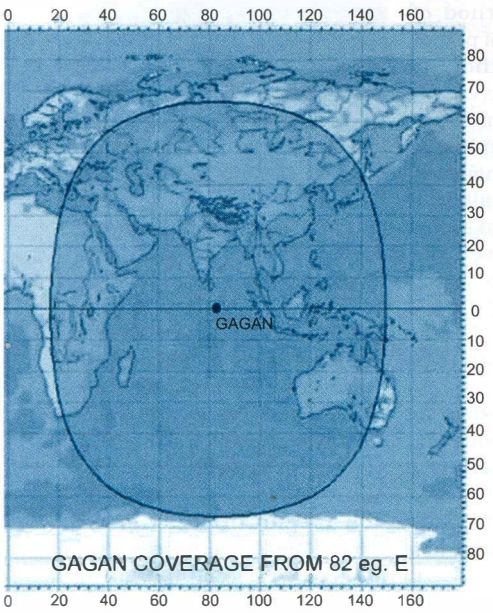


GAGAN and other satellite-based augmentation systems in the world

GAGAN is not the only SBAS for navigation of civil aviation. The USA commissioned its SBAS version known as Wide Area Augmentation System (WASS) in the early 1990s.

The experience gained during GAGAN implementation will lead us to the successful completion of the tasks related to the establishment of the indigenous Indian Regional Navigation Satellite System

exact location in the sky. The pilot can use this information for the navigation *en route* and for landing. The pilot can also broadcast this information, along with other aircraft-specific data to other planes and to the air traffic control facilities to obtain seamless navigation service for all phases of flight from takeoff to landing over the Indian airspace.



GAGAN COVERAGE FROM 82 eg. E

Implementation: All the ground systems consisting of the 15 INRESs, the Master Control Center, and the uplink stations are already in place. As of October 2008 final site acceptance test of the ground segment, their integration and connectivity have been completed. These tests have demonstrated that GAGAN is capable of better than 7.6 meters accuracy in both vertical and horizontal, and time to alert better than 6.2 seconds, meeting the ICAO standards.

The satellite-based navigation system, after all the three satellites are in position, is expected to be made fully operational and certified in the coming years. ISRO provides the technology support, maintenance and replenishment of the space segment of the system. The Airports Authority of India is working along with ISRO for the successful implementation of GAGAN as a partner.

Interoperability and compatibility: GAGAN is not the only SBAS for navigation of civil aviation. The USA commissioned its SBAS version known as Wide Area Augmentation System (WASS) in the early 1990s. Since then the European Geostationary Navigation Overlay System (EGNOS) and the Japanese Satellite Augmentation System (MSAS) are in the process of making their systems operational over their respective airspaces. All these systems use the GPS as the core satellite constellation and comply with the ICAO standards. GAGAN's footprint, while covering the Indian air space, overlaps the EGNOS and MSAS footprints, enabling it to provide seamless navigation to aircrafts on a global scale and providing interoperability. All the above mentioned systems are designed to ensure mutual compatibility.

GAGAN, although being built primarily for civil aviation, can cater to other applications. All the GPS applications could advantageously use the GAGAN signal that will ensure not only accuracy but also integrity. Such applications in future may include Railways and Maritime vessels.

Individual users in our country can also benefit from GAGAN since the higher positional accuracy will enable them to navigate themselves through the narrow lanes in both urban and rural areas which otherwise will be difficult.

GAGAN service is free of charge. Anybody in the coverage area and possessing the commercially available special GPS receivers can get the benefits of GAGAN.

The experience gained during GAGAN implementation will lead us to the successful completion of the tasks related to the establishment of the indigenous Indian Regional Navigation Satellite System (IRNSS). When that happens in a couple of years, our country will have firmly established itself in the field of satellite navigation.

Dr M.S.S. Murthy retired as Head, Radiological Physics Division, Bhabha Atomic Research Centre (BARC). Address: B-104, Terrace Garden Apartments, 2nd Main Road, BSK IIIrd Stage, Bangalore-560085

Dr K.N. Suryanarayana Rao is Former Project Director, GAGAN, ISRO

HAMLET Against Cancer

A protein normally found in breast milk has emerged as a potent weapon against cancer.

Human alphalactalbumin is a relatively small protein, consisting of 123 amino acids, has a molecular weight of 14.2 kDa, and is expressed in the lactating mammary glands. HAMLET is a molecular complex of partially unfolded human alphalactalbumin and oleic acid. Calcium has been found to be associated with alphalactalbumin.

The HAMLET complex was isolated by chance while using breast milk fractions to study attachment of bacteria on lung carcinoma cells. The remarkable property of this complex is that it is reported to selectively induce apoptosis in malignant cells and spare normal cells. Since the discovery of HAMLET many proteins similar to human alphalactalbumin, such as bovine alphalactalbumin and equine lysozyme, have been shown to induce selective apoptosis in tumor cells when coupled to oleic acid.

HAMLET infusions were shown to reduce tumor size and delay symptom development without toxicity in human glioblastoma samples transplanted in rat. Mouse bladder cancer was treated with HAMLET, and subsequent reduction in tumor area was shown. Also, whole body imaging showed selective uptake and retention of HAMLET by tumor tissue. Human studies of bladder cancer have shown that HAMLET treatment leads to reduction in tumor size and rapid shedding of cells from the tumor.

Cancer is perhaps one of the most ancient and depilating clinical diseases known, however chemotherapeutic agents that are broad spectrum besides being safe and effective are few. The anti cancer activity of HAMLET has been shown in over 40 different cell lines, including those of carcinomas of lung, throat, kidney, colon, bladder, ovaries and prostate as well as in melanomas, glioblastomas and leukemias. The anti cancer effect is not confined to primates, since the complex has also been shown to be effective in cell lines of bovine, murine and canine origin.

It has been previously shown, that breast fed children show lower incidence of childhood cancers and childhood tumors are about two fold less prevalent in them, than in bottle fed children. The acidic pH of the newborn's stomach and the release of oleic acid by pH sensitive lipase may contribute to the formation of HAMLET in the GI tract of the infant.

Contributed by Mr Asim Rizvi, MSc Biotechnology at the Interdisciplinary Biotechnology Unit, Aligarh Muslim University, Aligarh-202002; Email: rizvirizviasim@gmail.com

Kushal Performance!

ALMOST 90% of the rural and 38% of the urban population in Madhya Pradesh cook using firewood with traditionally inefficient cook stoves called *chulhas*. Cooking on a *chulha* requires a large collection of firewood resulting in destruction of forests. A *chulha* is also smoky and inefficient at converting biomass energy into heat. Consequently, the amount of firewood consumed each year can reach up to 4 tons per household. The excessive usage of firewood over and above the natural re-growth of wood causes local environmental problems.

Rahul Rai, a mechanical engineer with a degree in Power Management from the National Power Training Institute (Delhi), has now come up with an improved cook stove called *Kushal* whose efficient design ensures complete

Time to Bid Adieu to 'pi' Finally?

SOME mathematicians have recently started a hot campaign for replacing the mathematical constant 'pi', considered to be a very important number, with a new constant 'tau'. They are of the view that it is more rational as well as convenient to use tau in place of pi, which represents the ratio of the circumference of a circle to its diameter.

The number pi, which is represented by the Greek letter ð, appears as an important constant in many mathematical formulae and is vital to equations in science and engineering. The familiarization of students with pi occurs in schools in their mathematics curricula. Multiplying the diameter of a circle by the value of pi yields its circumference. Multiplying the square of the radius of the circle by pi, similarly, yields its area.

Mathematically, pi is not an exact number. It is an irrational number as its value cannot be expressed exactly as the ratio of two integers. Therefore, the decimal representation of pi never ends or repeats. Pi is also a transcendental number, which means that no finite sequence of algebraic operations (powers, roots, sums etc.) on integers can be equal to its value.

The approximate value of pi is taken to be 3 1/7 or 3.14159. It may be mentioned that the ancient mathematicians had to struggle hard calculating the value of pi. The Greek mathematician Archimedes was the first who succeeded in calculating a reasonably accurate value of pi. He said that the value of pi must lie between 3 10/71 and 3 1/7. However, he used a totally different method of calculating the value of pi that resembled the method of integration later given by Newton. In view of Archimedes' contribution, the number pi was also called the Archimedes' constant. It was actually the mathematician William Jones who in 1706 first used the Greek letter ð (which is the sixteenth letter of the Greek alphabet) for pi. Later, Leonhard Euler further popularized it in 1737.

In a report published in the *Daily Mail*, Kevin Houston, who is a mathematician associated with the University of Leeds, said, "Mathematicians measure angles not in degrees but in radians. There are 2ð radians in a circle. That leads to all sorts of unnecessary confusion. If you take a quarter of a circle, it has a quarter of 2ð radians, or half ð. However, for the number of radians in three quarters of a circle, you have to think about it. It does not come naturally. How much simpler it would be if we just used tau instead of pi. The circle would have tau radians, a semi-circle would have half tau, a quarter of a circle a quarter tau, and so on. You don't have to think."

Interestingly, the campaign for replacing pi with tau rose to the peak on 28 June. This is because, say some of the campaigning mathematicians, tau has a

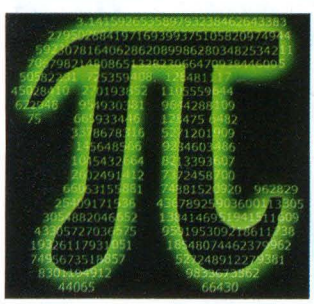
combustion. Developed with active participation of the community, users and experts, *Kushal* has a robust, maintenance-free design and is made of durable materials to ensure longer performance.

During an earlier stint as a carbon offset project consultant Rahul developed project design documents for solar lantern and solar water heater projects. As the co-founder of Parikrama Energy Services, he is in charge of the cook-stove project that has received the Atmosfair Renewable Energy Innovation Award for the year 2011.

With a height of 28 cm and a diameter of 24 cm, the efficient design of *Kushal* ensures complete combustion of fuel, cleaner fire and thus consumption of considerably less fuel as compared to traditional stoves. This means quick cooking, saving of time and fuel, cleaner pans, kitchen walls, indoor atmosphere and a better life for rural women. In field tests the stove registered a thermal efficiency of around 25%.

One of the first places where *Kushal* has been installed is in the school kitchen of village Samnapur near Jabalpur. Under the mid-day meal programme, the school provides lunch to almost 50 students enrolled there. The lunch is prepared by the local women's self help group (SHG). In the past, the SHG faced several challenges with regard to meeting the meal requirements of its students. These included attempts to ensure a steady fuelwood supply, increasing fuel needs as per rising student enrolment and complaints by kitchen staff about smoke and heat of the traditional stoves.

According to the SHG, after the *Kushal* stove was installed in late 2010, the school experienced a noteworthy range of benefits. It is now saving a lot of expenditure on fuelwood and the quality of food has improved with meals being served on time. The *Kushal* stove has transformed the kitchen environment and the women now enjoy better working conditions.



value twice that of pi i.e. 6.28 (28/6). Nonetheless, this campaign of mathematicians is under a cloud of controversy as many mathematicians are not in favour of it. They say that pi has now become so much part and parcel of mathematics, science and engineering that there is no point in tinkering with it.

Contributed by Dr P.K. Mukherjee, 43, Deshbandhu Society, 15, Patparganj, Delhi-110092

LIFE SAVER IN THE FOREST

IT could be a lifesaver were you to be stranded without water. *Calycopteris floribunda*, a large climbing shrub with slender brown streaked diffuse branches, stores water abundantly in its vines that are 5-10 m long and about 5-10 cm in diameter. It is found extensively in the low-lying tropical evergreen forests of the Western Ghats. *C. floribunda* belongs to the family Combretaceae and is commonly found around the forest area of Kerala. It bears grey bark and tenuous branches with thick fluff on the surface. The keratinous leaves, ovoid or oval, are 5-12 cm long. New branches are hairy and rust coloured. The flowers occur in dense clusters at the end of branches.

Ukshi, as it is known locally, is revered as a lifesaver by forest dwellers who depend on this vine during the hottest months when streams dry up. Sections of the vine store water, which people often use to quench their thirst. Nearly 0.5-1 litre of water can be collected by cutting the stem with the help of a sword or knife. There is no unwanted flavour or colour and the water is of potable quality.

The stem and leaves are also said to have medicinal properties. However, the medicinal uses if any of water stored in the stem are not known. It is still not known how plants of *C. floribunda* can store such large amounts of water in their stem. It is thought that the water may be backflow from the xylem vessel.

Dr. R. Ramasubbu is associated with the Horticulture Section, CSIR Madras Complex, CSIR Campus, Taramani, Chennai-600113, Tamil Nadu.

DISTINGUISHED RECOGNITION

EMINENT Indian theoretical physicist Prof. Ganapathy Baskaran of the Institute of Mathematical Sciences, Chennai, has been appointed as a Distinguished Research Chair at the Perimeter Institute, Waterloo, Ontario, Canada, along with seven others.

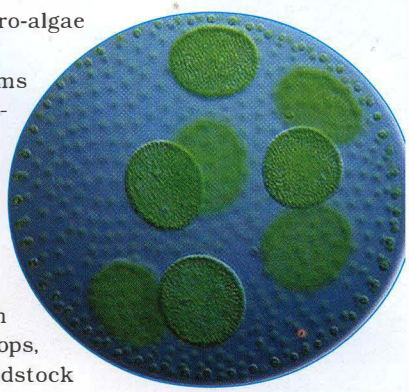
Distinguished Research Chairs come to PI for extended periods each year to do research. The program enables them to be part of Perimeter's scientific community while retaining permanent positions at their home institutions. The new appointees join PI's 19 current Distinguished Research Chairs.

Prof. Ganapathy Baskaran is an Emeritus Professor at the Institute of Mathematical Sciences, Chennai in India, where he has recently founded the Quantum Science Centre.

He has made important contributions to the field of strongly correlated quantum matter. Novel emergent quantum phenomena in matter, including biological ones, are his passion and research focus. He is well known for his contributions to the theory of high temperature superconductivity and for discovering emergent gauge fields in strongly correlated electron systems. He predicted p-wave superconductivity in Sr_2RuO_4, a system believed to support Majorana fermion mode, which is a popular qubit for topological quantum computation. In recent work, he predicted room temperature superconductivity in optimally doped graphene.

MICROALGAL OIL FOR BIODIESEL PRODUCTION

EDIBLE and non-edible vegetable oil is today being used for biodiesel production. However, there are limitations like the need for arable land for cultivation, long growth period and competition with the edible oil market. To overcome these limitations, scientists have now turned to micro-algae for Biodiesel production.



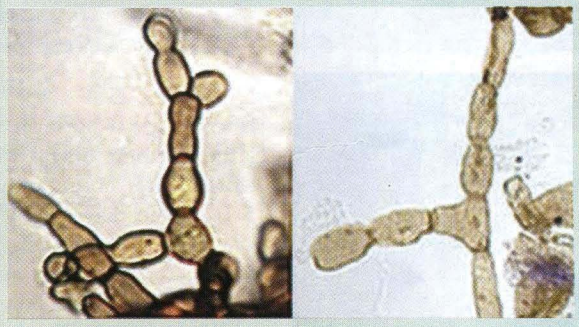
Micro-algae are photosynthetic microorganisms found everywhere on the earth. Each cell of the micro-algae works as a small factory of oil production in comparison to seeds of a crop plant used as oil source. Thus it gives much more oil to total mass ratio as compared to vegetable crop oil.

Some micro-algae like *Botryococcus braunii, Chlorella* sp., *Dunaliella primolecta, Nannochloris* sp., *Schizochytrium* sp., *Scenedesmus* sp. etc. have been reported as good sources of oil. Unlike vegetable oil crops, micro-algae can grow fast, no competition with feedstock as in the case of edible oil and no agricultural field requirement. Some environmental issues have also been solved like wastewater treatment by using it as the medium for growth and CO_2 released from industry being used up in photosynthesis.

All over India several institutes and labs have initiated research in micro-algal biodiesel production. Although micro-algal biodiesel has several advantages over other fuel sources, harvesting is still a challenge and requires further research. Moreover, theoretical projections of micro-algae production have not been realized practically. Field demonstration projects are necessary to advance understanding of this area. Future research should focus on the improvement of production systems and the genetic modification of strains. The use of transgenic micro-algae for biodiesel production has not yet been reported but holds significant promise.

Contributed by Mr Amit Kumar Singh, Pocket D-823, Dilshad Garden, New Delhi; Email: amitbotkgp@gmail.com

NEWS BRIEFS



■ The demise of the world's forests some 250 million years ago likely was accelerated by aggressive tree-killing fungi triggered by global climate change, according to a new study. The researchers do not rule out the possibility that today's changing climate could cause a similar increase in pathogenic soil bacteria that could devastate forests already stressed by a warming climate and pollution. The scientists claim that thread-like microfossils are relatives of a group of fungi, *Rhizoctonia* that attack and kill plants.

■ Scientists have known for some time that 'clonal' (regenerant) organisms are not always identical: their observable characteristics and traits can vary, and this variation can be passed on to the next generation. A new study of plants has shown why cloned plants are not identical: the genomes of regenerant plants carry relatively high frequencies of new DNA sequence mutations that were not present in the genome of the donor plant. Where these new mutations actually come from is still a mystery.

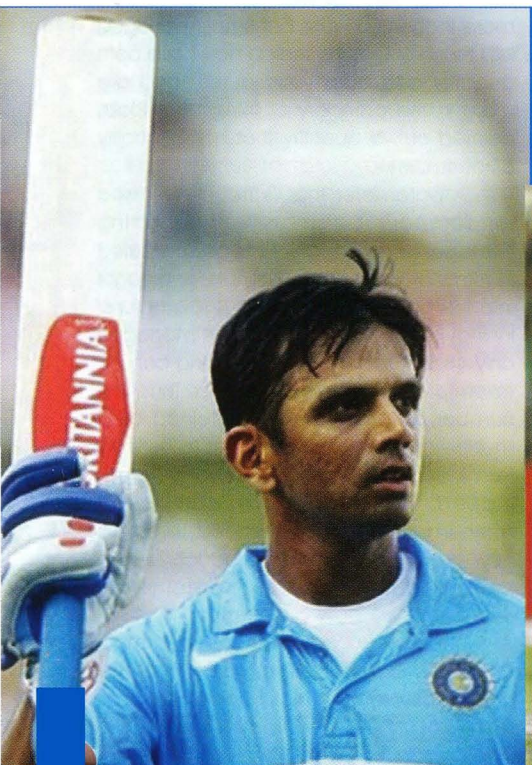
■ Recent research reveals that plants have their own chat systems that they can use to warn each other. Many herbal plants such as strawberry, clover, reed and ground elder naturally form networks. Individual plants remain connected with each other for a certain period of time by means of runners. These connections enable the plants to share information with each other via internal channels. They are therefore very similar to computer networks.

Sachin

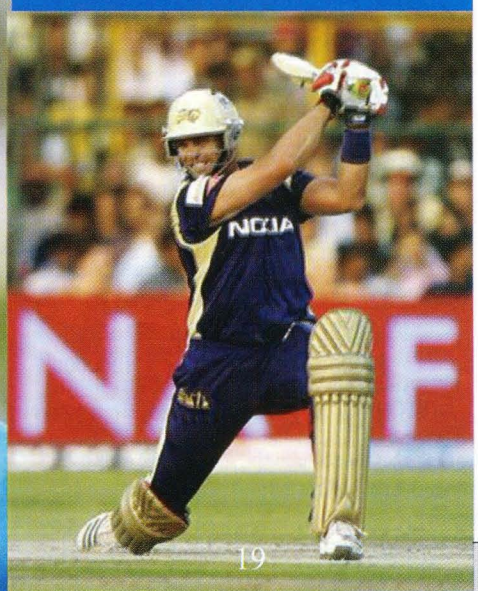
If there is a prize for the most consistent test batsman, does Rahul "The Wall" Dravid stand a chance?

The Most Consistent Test Batsman

GANGAN PRATHAP



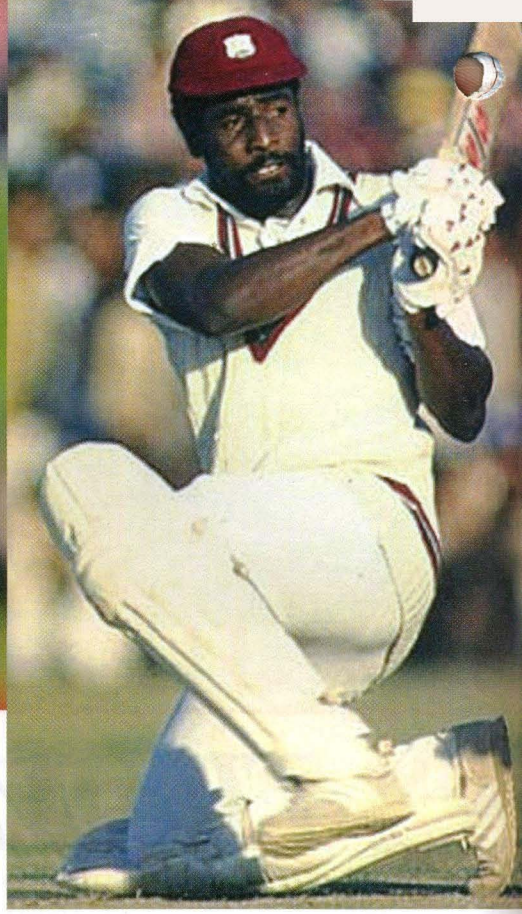
Rahul Dravid (left) and Kallis are two solid batsmen (below).



To every Indian, Sachin Tendulkar is the greatest Test batsman that ever was. No doubt Bradman had a higher average. Recently, another Indian test batsman was in the news. Rahul "The Wall" Dravid became the second highest run-getter in Test cricket, ahead of Ricky Ponting and just behind Sachin.

Sachin, is probably the most successful, when both quantity and quality of performance is taken into account. And for sheer quality of performance, if this can be measured by the batting average, surely Bradman towers above one and all. But then, if there is a prize for "consistency", is "The Wall" then the most consistent batsmen?

That calls for a definition for consistency. Here is where the quasity-exergy theory becomes useful (www.quasity.com). How does one identify the best sportsman? Or the most valuable? The task is difficult because one has to deal



Kallis has been consistent all along his career. In the early part of his career, Dravid was playing more consistently than the rest. Lara, perhaps the most gifted, is also the most unpredictable.

with measures that are purely quantitative and measures that are a proxy for quality.

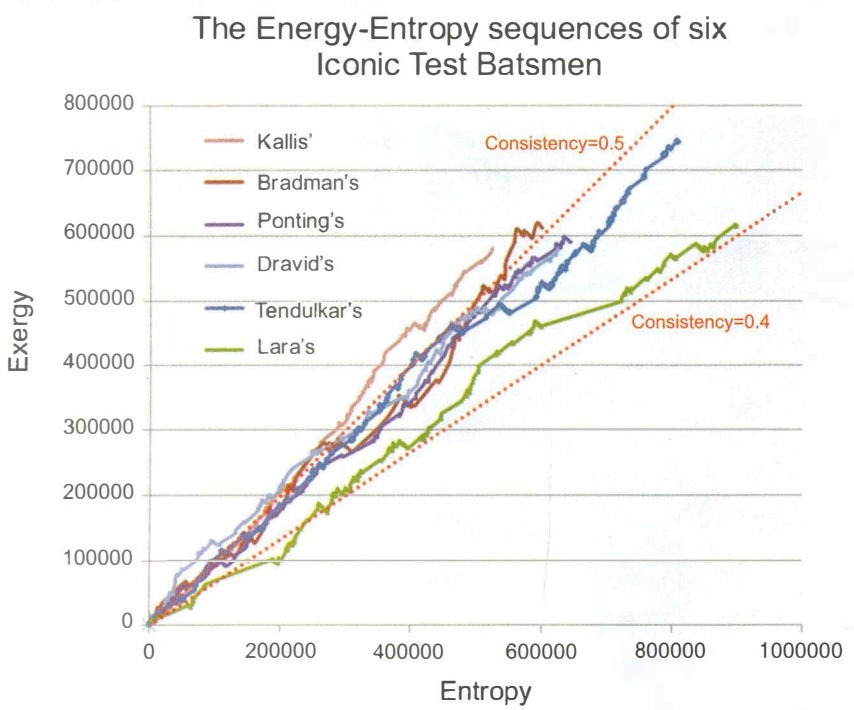
To illustrate, one can compare two batsmen using the number of innings they have played. Cricketer A may have played 260 innings in his career and B 80 innings. This is the simplest level at which assessment is done and these are virtually pure quantitative terms. Even this statement needs some clarification.

Joseph Stalin famously pointed out that *"Quantity has a quality all of its own."* Taken at face value that A has played 180 innings more than B is itself a statement about the quality of A as a batsman when compared to B. However, how did they actually perform when they went out to bat? Here, we may find that A has scored more than 12000 runs but B has managed less than 7000. Runs scored now have both quantity and quality attributes, and are more in the category of things that Stalin pointed out, a quantity that has a quality all of its own.

A parameter that is frequently used to compare batsmen is the batting average: we can think of this as computed in terms of runs/inning. When this is brought into the picture, we see that B (87.45 runs/inning) is in a class of his own (A managed only 48.94 runs/inning). Runs/inning can be taken to signify quality of batting. Thus, the number of runs scored is obtained as a multiplicative product of innings (a quantity term) and runs/innings (a quality term). Indeed, in metaphysical, and mathematical terms, we need to find a new terminology for this product. Hence the introduction of the metaphysical relation:

quasity = quality x quantity.

For a batsman, runs take the role of the quasity term, which combines both



The Energy-Exergy-Entropy sequence shows how consistent Kallis has been all along his career. In the early part of his career, Dravid was playing more consistently than the rest. Lara, perhaps the most gifted, is also the most unpredictable.

Table 1. Statistics for leading run-getters in the history of Test cricket from the Cricinfo website after analysis reveals that in terms of sheer effort, as measured by Innings batted, Runs scored, Energy and Exergy, Tendulkar ranks above the other five. In quality terms, as expressed by the average number of runs scored for the opportunities one has had at the crease, Bradman towers above the rest. But when it comes to consistency with the bat, Kallis' fans would rejoice to see that he forges ahead of Bradman.

	Innings	Runs	Average	Energy	Exergy	Consistency
Kallis	246	11947	48.57	1105281	580206.5	0.52
Bradman	80	6996	87.45	1212502	611800.2	0.50
Ponting	259	12363	47.73	1234445	590130.4	0.48
Dravid	267	12453	46.64	1205827	580813.5	0.48
Tendulkar	292	14738	50.47	1552562	743865.2	0.48
Lara	232	11953	51.52	1514553	615837.1	0.41

How does one identify the best sportsman? Or the most valuable? The task is difficult because one has to deal with measures that are purely quantitative and measures that are a proxy for quality.

In quality terms, as expressed by the average number of runs scored for the opportunities one has had at the crease, Bradman towers above the rest. But when it comes to consistency with the bat, Kallis' fans would rejoice to see that he forges ahead of Bradman.

quality and quantity of cricketing performance. Sadly, this is not enough to compare two batsmen. A batsman who has scored 2000 runs from 40 innings (batting average of 50) is not necessarily better than a batsman who has scored 1500 runs from 20 innings (batting average of 75).

We need a composite indicator that can combine quality and quantity, or quality and quasity, in a more helpful manner. Here, studies in a field called scientometrics (or bibliometrics), where scientific output is assessed, showed that a single indicator with energy-like properties can be defined to combine size and quality of scientific output. The proxy for the energy of scientific ideas turns out to be of the form:

exergy = quality x quasity = quality x (quantity x quality).

The exergy technique can easily be extended to sports, where performance statistics can be grouped as indicative of size (the quasity term R for runs scored, wickets taken, etc.) or of quality (r for batting average, bowling average, etc.) and the exergy term becomes $X = rR$. We shall now use this indicator to rank cricketers. Note that the quantity term is the number of innings I played so that the quasity term becomes $R = rI$, in the case of batsmen.

If the quality of a batsman is expressed in terms of the runs scored per innings ($r = R/I$) and the size of the effort over a fixed period (where R is the total runs scored over an entire career), then $X = rR = (R/I)$. R is a performance measure that reconciles both size of effort and quality of effort into a single indicator.

The exergies for batting performance is then defined as $X = (R/I)^{\wedge} R$. This is actually an energy-like term. What then is the energy of the runs from a single innings? If r_i is the number of runs scored in the i^{th} innings, then $e_i = r_i^2$ is the energy of this single effort. This leads to some curious definitions.

First, for I innings, $R = \sum r_i (i = 1 \text{ to } I)$. Now, the total energy of all I innings can be obtained by adding all the energies of the individual innings. That is $E = \sum e_i = \sum r_i^2$. One will then find that over I innings, as no batsman is uniformly consistent, r_i will vary significantly. In such a case, one can show that almost always, $E > X$. In the case of the ideal batsman, who has $r_i = r$ for every innings he has played, $E = X$. In thermodynamic terms, due to the inherent inconsistencies and unevenness in all natural and social systems, the shortfall between E and X is identified with what is called an entropy term S. The ratio X/E becomes the simplest measure of consistency. X itself is the measure of the total performance of a batsman.

Let us now apply this theory to identify who among the icons of cricket today, counts as the best, and/or the most consistent. We collect data for five leading run-getters in the history of Test cricket from the Cricinfo website (http://stats.espncricinfo.com/ci/engine/stats/index.html?class=1;template=results;type=batting). Also, for purposes of comparison, we collect information about Bradman. Table 1 displays the salient figures.

There is no doubt that in terms of sheer effort, as measured by I, R, E and X, Tendulkar ranks above the other five. In quality terms, as expressed by the average number of runs scored for the opportunities one has had at the crease, Bradman towers above the rest. But when it comes to consistency with the bat, Kallis' fans would rejoice to see that he forges ahead of Bradman. In fact, it is interesting to see this plotted on a map as shown in Figure 1 in the previous page.

The Energy-Exergy-Entropy sequence shows how consistent Kallis has been all along his career. In the early part of his career, Dravid was playing more consistently than the rest. Lara, perhaps the most gifted, is also the most unpredictable.

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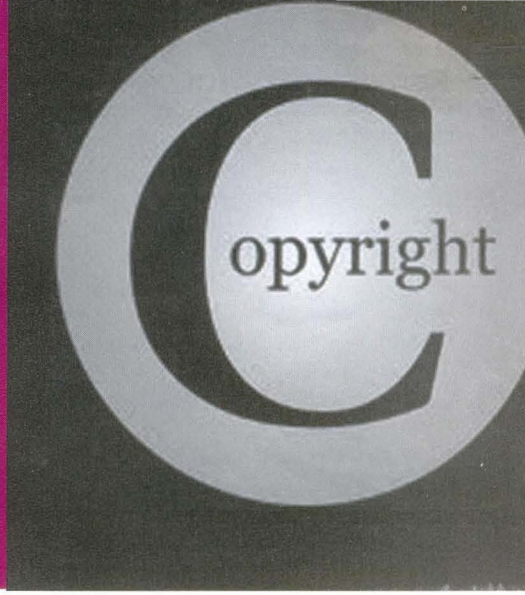
TRIPS
Fifteen Years and After

ARCHITA BHATTA



The TRIPS agreement has not been able to deliver the benefits promised to developing countries, which now need to plan ways to ensure that strict IP regimes do not become a tool for pharma companies in developed countries to milk the poor in the developing world.

FIFTEEN years after the signing of the Trade Related Intellectual Property Rights (TRIPS) agreement, experts from developing countries are trying to find ways to guard against rising cost of technology and healthcare due to it.

TRIPS agreement signed in 1994 required developing countries to bring about significant changes in their Intellectual Property (IP) laws to raise their standards of intellectual rights protection. As a result, costs of technologies like climate change related and healthcare related ones increased significantly.

Southern experts suggest stronger technological co-operation between southern countries and wise use of the flexibilities offered under the agreement to prevent rising costs and of technology and increase their access under the TRIPS regime.

TRIPS—What for Developing Countries?

The TRIPS agreement that was conceived to expand and strengthen intellectual property rights has not been able to deliver the benefits promised to developing countries at the time of its signing—namely transfer of technology, stimulation of local innovation and increase of foreign direct investment.

Developed countries prompted the negotiation of the TRIPS agreement on the argument that an expanded and strengthened protection of Intellectual Property Rights (IPRs) would bring about increased flows of foreign direct investment (FDI) and technology transfer to developing countries and those changes in IPRs would also stimulate local innovation.

"The experience of implementation of TRIPS suggests that serious doubts can be raised about the extent to which such positive effects of TRIPS have been realised," Abhijit Das, head of the centre for WTO studies at the Indian Institute of Foreign Trade (IIFT) said at a conference that reviewed the impact of TRIPS on developing countries.

He added that studies at the IIFT show that the agreement favoured the developed countries whose multinational companies held patents over many high technology products that they could manufacture or sell at very high prices.

According to Martin Khor, executive director of the South Centre, an NGO working on intellectual property issues, the changes in the IP laws of developing countries due to the agreement, adversely affected access to medicines, infringement of farmers' rights, bio-piracy and barriers on industrial technology transfer.

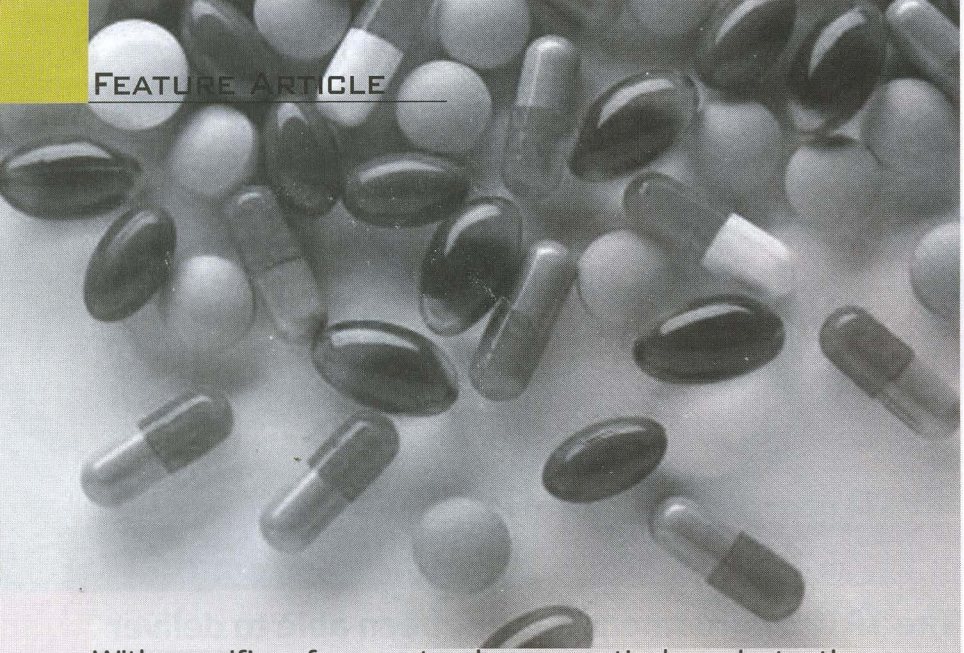
"In the push for higher standards of intellectual property rights protection by developed countries, social and economic concerns of developing countries was ignored at TRIPS," Das pointed out.

TRIPS-plus Looms Large

Now there are efforts to push the standards even higher. Developed countries are forcing developing countries to comply with more stringent IP laws through TRIPS-plus provisions that the latter have been coaxed to sign in lieu of bilateral free trade agreements. TRIPS-plus makes the IP protection requirements more stringent than TRIPS.

According to Carlos Correa, Director of the Centre for Interdisciplinary Studies on Industrial Property and Economic Law at the University of Buenos Aires, the provisions include extension of patent term beyond 20 years, grant of exclusive rights over data on pharmaceutical products, obligation to refuse marketing approval to a generic version of the product.

Under TRIPS agreement, patents must last for 20 years from the date of



With specific reference to pharmaceutical products, the Doha Declaration, exempts least developed countries from having to grant patents and from providing for the protection of undisclosed information until 1 January 2016.

application. TRIPS-plus provisions extend the period beyond 20 years (usually indefinitely) with the excuse that need to obtain marketing approvals for new chemicals takes time and reduces the effective term of patent protection and possibility of recovering research and development funds.

FTAs promoted by USA led to obligations by some countries to extend the patent term to compensate for delays in the examination of patent application and in the process of marketing approval and this prevented access to several dugs at an affordable cost.

Sanya Reid Smith, legal adviser at Third World Network, an NGO working on developmental issues, in a paper presented at the conference showed that in Jordan extension of patent term, grant of exclusive rights over data, increased the price of medicines by 20% since 2001 when the Jordan-USFTA began while extension of patent term by 3 years in Korea would cost $ 529 million.

The TRIPS agreement requires WTO members to protect undisclosed test data on pharmaceutical products against unfair competition. Under this rule, members are not obliged to grant exclusive rights over data.

However, FTAs negotiated by USA oblige the parties to grant exclusive rights for at least five years counted from the date of approval of the product, irrespective of whether it is patented or not and in most cases, whether the data are undisclosed or not. It covers chemical entities that are not new as they may have been previously approved in other territories.

This may be of particular significance in countries that have recently introduced patent protection for pharmaceutical products. In these countries, medicines that are off-patent may become subject to exclusive rights. This creates an effective barrier to competition from generics because marketing approval cannot be granted to generic manufacturers even for medicines that are off-patent unless they replicate the full set of data necessary to obtain approval—a process that is costly and time consuming.

FTAs insist that the national drug authority must refuse marketing approval to generic version of a product if a patent is in force, unless the patent owner consents to it. The authority is also required to inform the patent owner about applications for the approval of the generic drug. This shifts the onus of responsibility to prevent possible infringement to the state authorities in developing countries who lack the knowledge and experience to assess the claims of a patent or its possible infringement.

Besides, under a linkage system, pharmaceutical patents that cover a wide range of chemical entities like salts, esters, ethers apart from the main active ingredient may become a serious obstruction to generic competition.

FTAs with their perceived benefits are being used as a carrot to make developing countries comply with TRIPS-plus provisions. For example, Europe is pushing for restriction of affordable generic medicines as part of the 'investment chapter' in its trade deal with India.

Other methods adopted to ensure that developing countries comply to such provisions include adopting new rules and programmes that give mandate to custom authorities and postal services of the respective countries to become IP enforcement agencies with the responsibility of seizure of consignments of generic medicines in transit from one country to another even though their use is perfectly legal in both countries.

Solution in South-South Technological Co-operation

Government representatives and civil society groups from developing countries believe that in the face of such attempts developing countries could share the technological resource base that exists with them and establish their own intellectual property regime to keep the cost of technologies like climate and health care related ones low.

"We need to strengthen the technological pool in the south and benefit from each other's innovations instead of being dependent on developed countries and wasting our energies opposing the regime they are imposing on us," said Rajeev Kher, Additional Secretary to Government of India, at the workshop on '15 Years of TRIPS: Rethinking Intellectual Property and Development'.

"Closer ties and stronger co-operation among developing countries could help developing countries establish their own IP provisions and stop being dictated by the IP regime established by the developed world," Khor said supporting Kher's suggestion.

TRIPS Flexibilities

The TRIPS agreement also provides for some flexibility that developing countries can use to address the economic and social concern of these countries. While the bilateral agreements or free trade agreements try to nullify many of these flexibilities, the challenge before

Before the WTO Hong Kong Ministerial Conference, the WTO TRIPS Council extended the transition period for least developed countries from mandatory compliance with the TRIPS agreement until July 2013.

developing countries is to make most efficient use of these flexibilities.

The World Health Organization (WHO) Global Strategy and Plan of Action on Public Health, Innovation and Intellectual Property urges governments to "consider, whenever necessary, adapting national legislation in order to use to the full flexibilities contained in the agreement on Trade-Related Aspects of Intellectual Property Rights, including those recognized by Doha.

Despite the opportunities provided by TRIPS flexibilities, many countries have yet to amend their laws to incorporate optimally the flexibilities, which is a precondition for their use. A UNDP study conducted in 2007 found that only six countries had a provision on the international exhaustion of rights in their legislation. However, countries like Brazil, Thailand, Rwanda and India have shown how the flexibilities can be used to ensure access to medicines within the TRIPS regime.

The Government of Brazil demonstrated that public health related flexibilities could be effectively used to negotiate lower prices for antiretroviral drugs. Using the threat of compulsory licensing, it brought about significant price reductions of efavirenz and nelfinavir in 2001, lopinavir in 2003, the combination of lopinavir and ritonavir in 2005, and tenofovir in 2006. In 2007, after protracted negotiations, a compulsory licence was issued for efavirenz, an important antiretroviral drug used by a third of Brazilians on treatment through the national programme bringing down the price of the drug from $1.60 per dose to $0.45 per dose for the imported generic version.

In 2006, Rwanda passed a law requiring generic medicines to be used for all treatment programmes when available and in July 2007 it became the first country to announce its intention to use the WTO 30 August 2003 decision to import a generic fixed-dose combination of zidovudine, lamivudine and nevirapine from a Canadian generic manufacturing company. The compulsory licence issued under the Canadian Access to Medicines Regime authorized the delivery of enough of this fixed-dose combination for one year's treatment of approximately 21,000 people living with HIV at the most affordable price globally of $0.19 per tablet.

In late 2006 and early 2007, Thailand issued compulsory licences for medicines like efavirenz, lopinavir/ritonavir and clopidogrel (a drug used for heart disease). This decision prompted widespread protests from multinational drug companies, but by early 2008 the number of patients using lopinavir/ritonavir had tripled. In early 2008, the Thai Government issued additional compulsory licences for letrozole (a breast cancer drug), docetaxel (a breast and lung cancer drug) and erlotinib (a drug used for treating lung, pancreatic and ovarian cancer).

When revising its patent law to comply with TRIPS requirements of pharmaceutical products to make them patentable, India adopted stringent patentability criteria to prevent rampant patenting that could affect the generic medicine industry in the country and hamper access to cheaper medicines. It introduced Section 3d into its Patent Act, according to which "the mere discovery of a new form of a known substance that does not result in the enhancement of the known efficacy of that substance or the mere discovery of any new property or new use for a known substance or of the mere use of a known process, machine or apparatus unless such known process results in a new product or employs at least one new reactant" is not considered an invention and is thus not patentable under the Indian Patents Act.

Other countries can learn from these examples and plan ways to ensure that strict IP regimes do not become a tool for pharma companies in developed countries to milk the poor in the developing world and deny them their rights to better health by making medicines more and more difficult for them to procure.

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THE FLEXIBILITIES UNDER TRIPS

Compulsory licences: Mechanism used by public authorities to authorize use of a patent-protected invention by the government or third parties without the consent of the patent-holder. Countries can decide on the grounds on which it is granted and are usually resorted to for public health emergencies. Patent-holders receive compensation, usually in the form of a royalty.

Parallel imports: Companies often charge lower prices for a medicine in one country than in another, taking into account a range of market factors. Many countries' patent laws determine that once a patent owner sells its goods in any country, it has no right to control the resale of those goods. This means that a country with limited resources can sometimes afford more of a patented medicine by purchasing it abroad at a lower price and importing it, rather than buying it directly in its domestic market at the higher price.

Bolar provision/regular exception: This permits the use of a patented invention without authorization from the patent owner in order to obtain marketing approval of a generic product before the patent expires allowing a generic product to enter the market more quickly after patent expiry, which in turn facilitates access to cheaper medicines.

Exemptions for least developed countries: In November 2005, before the WTO Hong Kong Ministerial Conference, the WTO TRIPS Council extended the transition period for least developed countries from mandatory compliance with the TRIPS agreement until July 2013. With specific reference to pharmaceutical products, the Doha Declaration, as implemented by a TRIPS Council Decision of June 2002, exempts least developed countries from having to grant patents and from providing for the protection of undisclosed information until 1 January 2016. These transition periods are subject to further extension upon duly motivated request.

"CORPORAL PUNISHMENT SHOULD BE ALLOWED IN SCHOOLS"

STRENGTHEN THE ROOT

I don't think corporal punishment is necessary in school level. It is an

unethical and inhumane behaviour. For making the students punctual and dutiful, a good teacher is required. A perfect teacher can control the utmost undisciplined student by his or her personality. Corporal punishment should be banned but a mass of well-educated, skilled personalities should mould the new buds at the early school level, so that when they blossom they will never be deviated from their path.

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DISCIPLINE IMPLIES EDUCATION

Schools are meant for education in a disciplined manner where child learns to do everything right under the supervision of teachers. But if left uncontrolled, they can deviate from the path. Punishment is one of the ways to prevent this. But this should be used in a limited way. Sometimes it becomes so harsh that children get badly injured both physically and mentally. Punishments are to make students conscious and alert at school, not to injure them. Allowing corporal punishment in schools will make children more alert and help to maintain discipline.

Shubham Kumar Singh
Patna, Bihar

CHILDREN SHOULD BE CONTROLLED

Nowadays, children are getting out of control of parents and teachers. They think that teachers will do

nothing and forgive them if they do something wrong. Corporal punishment should be given when a child avoids the advice of teachers. But punishment should be given only for a child's destructive activity, not for not doing well in studies. Because of the fear of punishment, the child will not do anything wrong.'

Shivam
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SPARE THE ROD AND SPOIL THE CHILD

Corporal punishment should be used as a wider strategy and at the correct time when other disciplines have failed. It is the most effective form of punishment in maintaining school discipline and dealing with juvenile delinquency. Students in the current public school system are becoming unruly due to relaxed discipline and uninvolved parenting. Detention methods are insufficient, and so discipline should be just and swift.

Today it is not teachers or school administrators who run the school but students who run the show. Teachers are unable to command respect, they demand it with the result students not only disrespect teachers but even resort to heinous crimes. To get respect authority is a must and teachers taking this step at the right time will create a more disciplined set of students.

The great poet Rabindranath Tagore was dissatisfied with the western model of education and was keen on the 'Gurukul System of Learning'. It was a system where students and teachers lived together & teachers treated the students as their own children. They exercised great patience but as a parental figure the Guru had the moral & scriptural authority to punish the students. Punishments like caning, fasting etc were given. The guru took it upon himself to rectify the erring students. Eminent people like President Abraham Lincoln and Swami Dayanand were caned in school but this did not deter them from becoming great people.

Today with abandonment of corporal punishment, students are resorting to drug addiction, boozing, delinquency, violence etc. Courts are clogged with juvenile crime. Many a life with sin & shame can be warded off with discipline. In my opinion, the best way to discipline students in school is 'Don't spare the rod as it spoils the child' as even the Bible says: *'He who spareth the rod, hateth his son: but that loveth him correcteth him.'*

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TEACHERS ARE HELPLESS

From a teacher's point of view, punishment is always given for the benefit of a student, not to oppress. But some times accidents do happen. So, teachers today avoid corporal punishment. But sometimes if a teacher scolds a student; smart students may show themselves as mentally harassed in front of others, some sentimental ones may even attempt suicide. So, how does a teacher control the bad behaviour of a fearless or shameless student? Teachers are helpless. We do not want to punish our sons/ daughters, because we are teachers not heartless butchers, but punishment should be allowed in schools to create some fear among bad guys.

Sudip Chakraborty, Kolkata

CORPORAL PUNISHMENT A CURSE

Corporal punishment is one of the worst nightmares for school students. Even adults can't bear such torture, then how can small kids bear the pain of corporal punishment. It not only affects the mental status of the student but also affects health. These lead to psychological

problems. Physical violence causes wounds that leave a huge impact mentally and physically. Since the past few years, teachers have become so violent that they have ended up killing many innocent students. Increasing anger and impatience is leading to loss of lives of students, which is highly shameful. So, banning corporal punishment in schools is a must.

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SHAPING FUTURE PERSONALITY

The school is an institution under the roof of which many innocent souls learn the art of living. Allowing

corporal punishment in such an institution do you think would be justified? Teachers build up the basic mindset of a child at school. The school environment influences a child to a great extent not only during the school life but also shapes up the child's personality in future life.

Therefore, teachers should not use physical threat to discipline a student understand. They should rather use friendly means so that a student enjoys his studies and bears a charming personality throughout his life.

Md Meraj Monazir
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RAISING STRONG CITIZENS

Corporal punishment is illegal. It is similar to a crime. It does not make a child responsible rather it makes them violent and aggressive. Such victims behave in the same abusive manner with their friends and juniors. In many cases, sensitive students are unable to bear the depression and commit suicide. Physical tortures like caning, slapping and hitting severely damages the internal body parts. Hence, corporal punishment affects a child both mentally and physically.

Teachers should remember that students are the future citizens of a country and it is their duty to make them mentally and physically strong with love, care, attention and proper guidance. Hence, corporal punishment should be banned in schools.

Sreyasree Mandal
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HAMPERING TALENT

It is physical and mental torture. Nowadays, corporal punishment is common in schools. Teachers who want to transform them by hook or crook prefer corporal punishment. They should be just expelled from the school because this malpractice can greatly hamper the talent of the students.

Utkarsh Rai, Class 9,
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FRIEND, PHILOSOPHER & GUIDE

No, we must not allow corporal punishment in schools. In school-life, the students' minds are very sensitive. Giving them corporal or physical punishment can create a bad effect in their mind. Then, they will respect their teachers out of fear, not from the depth of their heart. In many cases, they become so depressed that they find death is better than living. The teacher is a friend, philosopher and guide for a student. We should behave with the students as friendly as we can.

Raja Dikshit
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CAUSES ENVIRONMENT OF FEAR

No, corporal punishments are never to be allowed in schools. The school is a key ingredient in socialisation of young students. When corporal punishments are not allowed at military, mental institutions and prisons then why in the school, which is a temple of knowledge. Corporal punishment causes an environment of fear in the classroom and depression among students. As a result the all round development of students, which is the agenda of a school, is hampered.

Kanupriya
R.I.E, Bhubaneshwar
kanup.saha@gmail.com

LAND OF AHIMSA

Corporal punishment imprints a sign of force & violence in the clean minds of innocent children. The mind & heart of children are like mud pallet. Any incident can have a deep impact on them. So, the physical punishment given by the teacher too can hurt the innocent heart. A sense of fear, force & violence envelops their mind, which may lead to a negative attitude.

India is the land of Lord Buddha, who taught ahimsa & Gandhi who

proved it in the political spheres. Corporal punishment, which prevails in almost all schools seems to mock at the ideology of these great personalities. Media covers it too, but many times it goes unnoticed.

The teacher should be a role model for students and should handle children with care and patience.

Debasmita Patra
F.M. Autonomous College,
Balasore, Orissa

EMOTIONAL SCARS

Mostly school teachers try to show their heroism on kids, or school management is under intense pressure of performance, and at home parents are too much worried about their kid's career or compare their kid's performance with other kids families and finally end up beating them up.

Personally I don't believe that corporal punishment either at school or at home works in changing behaviour. It instills fear, not discipline, and it can do untold psychological harm and at times cause even death or permanent disability. I can't began to imagine the number of children who are growing up with emotional and physical scars in this country.

Rupak Roy
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PATIENCE REQUIRED

Some teachers argue that students become attentive when there is fear of punishment. Discipline must come from nature and certainly not from some outside enforcement. The best teachers never used any sort of punishment. From my interaction with students, I can say that each child learns in her or his own individual way and every child deserves all love and care we can provide. All we, as teachers, need is Patience.

Sitanshu Raj,
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EDUCATION WITH DIGNITY

I strongly opine that Corporal Punishment should not be allowed in schools for it is mental and physical abuse of child,

humiliating, harmful, and against the dignity and self confidence of the child and its rights. The Supreme Court of India banned corporal punishment for children on 1 December 2000, and gave the direction to the state that "Children should not be subjected to corporal punishment in school & they receive education in an atmosphere of freedom and dignity". The National Commission for the Protection of Child Rights also supports the opinion of the Supreme Court and also provides for forums and drop boxes to receive complaints of corporal punishments from both children and parents, and promises immediate action by Parent Teacher Associations on such complaints.

With love and affection, we can win over children, and inculcate discipline and interest in learning in them, and should not chastise them through brutal corporal punishment. I strongly advocate all states should strictly follow the Indian Supreme Court's direction, and ban corporal punishment in schools; in addition, teachers should be given orientation training from time to time in behavioural science and humanism. "Spare the rod and spoil the child", no longer holds good. Child abuse through corporal punishment is as bad and inhuman as ragging in college campuses. Already Europe, Canada, New Zealand, Japan etc have removed corporal punishment. The sooner it is stoped the betterfor the physical and mental well-being of children.

Nirmala P. Rao

DARK FUTURE

Punishment is given to someone to enable him or her to know that they have made a mistake and they should try to rectify it. If proper punishments are given to children then they would never commit the same mistake twice. Corporal punishments are not the way in which students get a chance to rectify themselves. Corporal punishments instill in them a sense of fear. It also affects their minds. They are terrified to go to school as a result of corporal punishments. And this results in a dark future for our young generation.

Saumoneel Mandal, West Bengal

ENCOURAGEMENT, NOT PUNISHMENT

Corporal punishment makes the children arrogant and bitter. The mental agony students undergo when they are humiliated and ridiculed in the presence of others is unimaginable. Pummeling a child or beating her only ingrains in her/his psyche that aggressive behaviour is a way life. There are disturbing trends of children fearing school because of the abuse they were subjected to. Every child wants to be treated with respect but the scars of the trauma suffered in school affect the child throughout life.

A spate of cases of children driven to death by corporal punishment has come to light in recent months, which have shocked the conscience of the nation. Corporal punishment and humiliation inflicted on children is also an important reason for many of them dropping out of school. Studies conducted by the Union Ministry of Women and Child Development show that two of every three school going children has been physically assaulted and mentally abused.

Discipline, as and when required, has to be firm but gentle. The youngsters should be corrected in a gentle and persuasive manner. Frequent parent-teacher interactions can help curb the menace of corporal punishment. School management must appoint teachers who not only hold the attention of the class but also are good human beings. Communication is very vital and teaches who have the skill can persuade erring students to take the correct path. Teachers must undergo compulsory orientation courses in child psychology. The National Commission for Protection of Child Rights (NCPCR) should direct district authorities across the country, instructing them to hold meetings with all the school heads and convey that no form of corporal punishment will be tolerated.

When education is a fundamental right the education system cannot wash its hands off a child. Here again there is a need for systemic reform to enable schools and teachers to provide different curricular experiences and activities to bring about greater awareness and change the so-called 'deviant' behaviour. Encouragement is needed for a child to develop, not corporal punishment.

Dr. S. K. Aggarwal, Dean Academic Affairs, Amritsar College of Engineering and Technology

NO ROOM FOR FEAR

In my opinion inflicting punishment on school going kids is not at all advisable, although earlier parents regarded it as a necessary evil and adopted a feigned ignorance when confronted with this problem. In present times, child psychology clearly rules out this treatment. A growing child deserves sympathetic consideration. A child is fragile and should be treated with care and affection. A renowned child psychologist has aptly said that for the full development of the child there should be no room for fear psychosis. The tiny lot should look upon the teacher as a guide and not as a tyrant.

Shashi, Indore (M.P.)

Solar Power Tree

Here's an idea for a Solar Power Tree that uses up very less land and yet generates much more energy from the sun's rays.

S. N. MAITY

Solar Power Tree for 1 kwh (Area 2.25 sq ft)

WITH demands for energy increasing with every passing day and energy generation from the available carbonaceous compounds posing the threat of greenhouse gas effect to the planet, there are worldwide efforts to tap into non-conventional energy sources. Renewable sources of energy or green energy sources like solar energy, wind energy, tidal power, hydro power etc. are most favoured today. However, given its abundance, power from the sun is the only major alternative as compared to other sources of renewable energy that are being tried to replace the conventional sources of energy like coal, gas, oil etc.

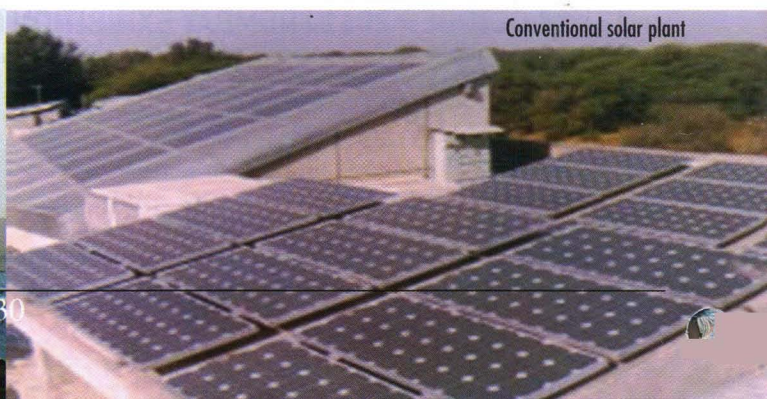
But tapping the power of the sun by harnessing its rays is not an easy job. Many ways have been devised from time to time for absorbing the sunrays coming towards the surface of the earth. The most efficient and simplest is the crystalline silicon photo voltaic (PV) module in solid form. There are other forms like amorphous or thin film etc., but the most efficient is the solid crystalline PV cell for direct absorption of sunlight. The other methods of sun absorption like reflection, concentration, water heating etc. are costly and complicated and the efficiency is also less compared to solid PV modules.

In India, solar power generation systems are generally being designed around the solid crystalline (PV) panels. One needs to erect the PV panels at an angle under the sun so that the surface of the panel gets the maximum sun of the day. Therefore, it is required to have a suitable structure over the landed area in an open space to hold the solar panels.

For example, the generation of 2MW power from a PV module system requires land of 10-12 acres approximately for housing the panels only. But land is going to be the greatest crisis on the earth—in fact, it is already a burning question in most countries. Cultivable land if used for purposes other than agriculture could lead to uncountable loss. Many national projects are also facing the severe problem of utilization of land. Therefore, if vast tracts of land are used for capturing solar power it would never be cost effective and viable for the human society.

Therefore, there is a need for devising a method and fabricating a suitable device so that the solar power can be absorbed without occupying much surface area or land which is going to be the costliest commodity in the near future. Rather, the device and method should be such that it would be utilizing the minimum land for maximum solar energy absorption by creating maximum solar surface. This is only possible by devising a holding system of PV modules with a tall vertical pole

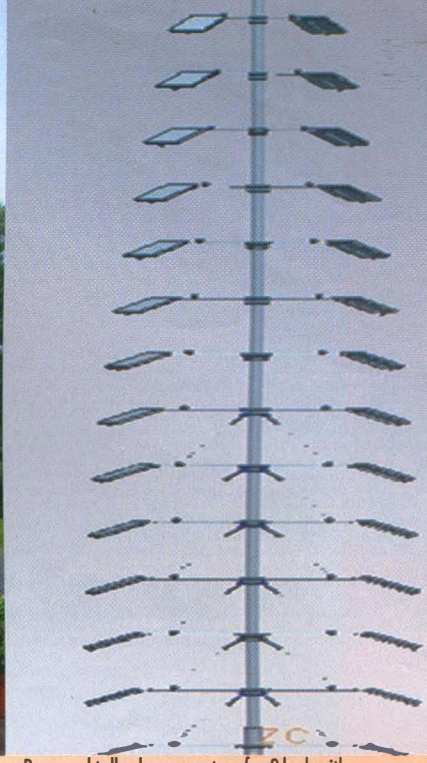
Conventional layout for 2 kwh (area 500 sq ft)



Conventional solar plant

Model of conceptual Solar Power Tree

Conventional solar panel & light



Proposed tall solar power tree for 2 kwh with PV Panels or Thin Films (area 5 sq ft)

standing on the ground holding the PV panels at a height.

The tall metallic pole of 50 to 70 feet height is founded on a basement of 2 X 2 sq feet or maximum 3 X 3 sq feet area. The maximum surface land thus used is merely 4 to10 sq feet. Of course, it needs some foundation for holding the taller pole but most of the foundation work will be under the ground level.

The uniqueness of this single pole system is that the solar PV modules will be installed throughout the tall pole following a pattern of spiralling phyllotaxi with due adjustment of load distribution over the pillar for its balancing and having reducing stem diameters from the bottom to top so that the shadows of upper panels would not interfere with the lower ones.

The other uniqueness is that all the solar panels will be hanging through their connecting stem-system attached with the main trunk (Pole) and may be made flexible in all directions so that they can best avoid the wind pressure due to heavy storm affecting the main pillar (trunk). Though the leaves (panels) will be spring-loaded and the joints of stems are flexible, they will be naturally facing towards the sun so that they can tap the maximum energy of the sun energies during the daytime.

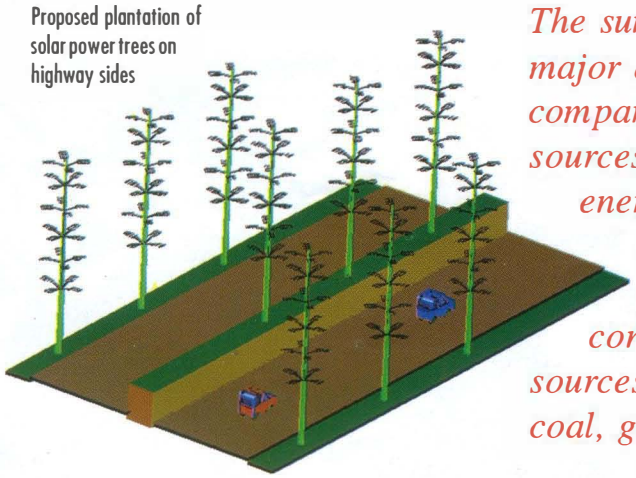
The major advantage of this system is that it takes about 1% of land area in comparison to general PV housing layout. For example, the proposed idea would requires 0.5 sq m basement for 2.2 KWH PV power whereas for the same solar power by the currently used method of housing the PV arrays a land of 50 sq m would be required.

The other advantage is that this system does not require acquiring of big landed property at a single place. Rather, for this type of solar power generation, road sides, islands in between wide roads, boundary walls of paddy lands, crossings of boundary walls etc. can be used.

Another advantage is that the shadow being created by the panels will not touch the land in most of the cases (as trees would be very tall) and even if it touches will not cover the surrounding field by its penumbra (as the individual panels are of small size) so that growth of plants would not be restricted in the cultivable land.

Just to take one example. If both the road side and island of the National Highway from Kolkata to Asansol (approximately 300 km) is used for plantation of solar power trees (SPT) it would produce about 110 MWH of solar energy which would otherwise require a piece of land of almost 700 acres for production of the same energy by the conventional method of panel layout.

Proposed plantation of solar power trees on highway sides



The sun is the only major alternative as compared to other sources of renewable energy that are being tried to replace the conventional sources of energy like coal, gas, oil etc.

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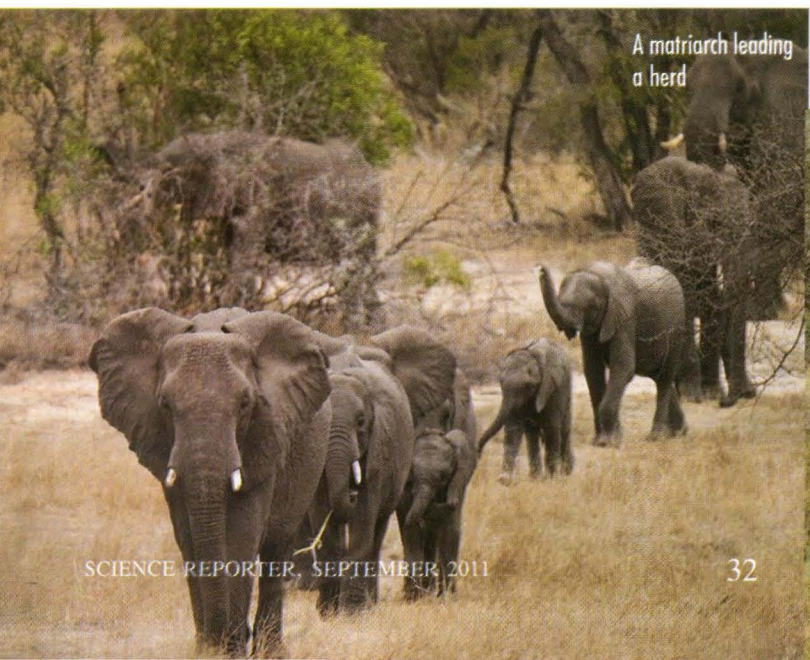
An elephant herd

Elephants are very social animals. They form close, lifelong relationships with their families. And when required, they help and comfort each other just as we do.

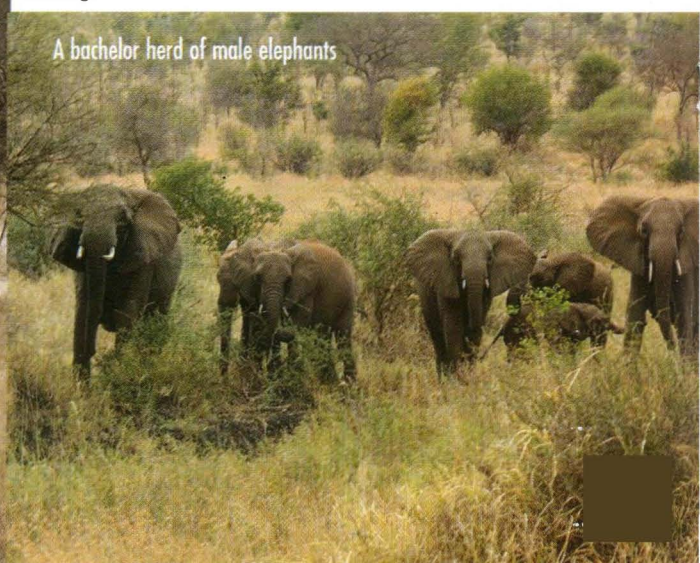
of 'Pachydermic' Bondage!

R. VATHSALA

WE talk so much about Human Bondage. How humans, being social animals, are emotionally attached to their kith and kin and fellow human beings. Humans consider themselves to be the pinnacle of modern evolution endowed with super brainpower, superior intelligence, great ability to judge between wrong and right, and a keen family feeling.

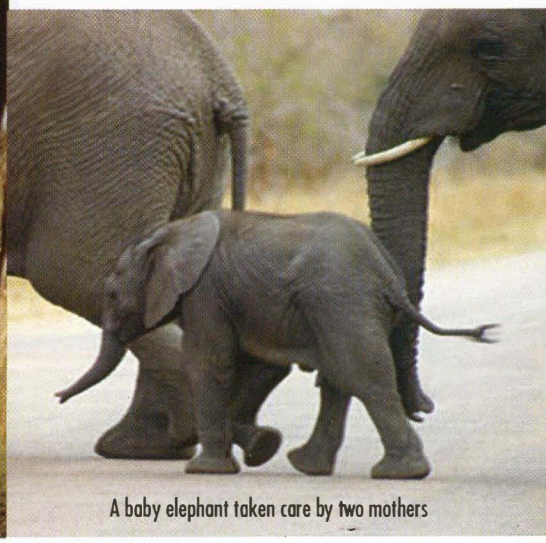


A matriarch leading a herd



A bachelor herd of male elephants

An injured elephant is pacified



A baby elephant taken care by two mothers

Elephants also communicate over long distances by producing and receiving low-frequency sound that can travel in the air and through the ground much farther than higher frequencies.

A Helping Trunk

A study published on PNAS.org on 7 March 2011 has shown that elephants might have shared goals, which gives them the ability to co-operate.

An experiment was done using the classical 1930s cooperation paradigm used to test the co-operative abilities of monkeys and apes. This paradigm is used to explore the cognition underlying coordination toward a shared goal. This explores what animals know or learn about the benefits of cooperation and also tests their ability to comprehend a partner's role in cooperation.

The experiment carried out by Joshu Plotnik and team at Lampang in Thailand comprises of two animals who need to work together to pull two ends of the same rope in order to pull a platform towards them which holds a reward such as food. They were made to walk into adjacent paddocks separated by a fence. In front of them was a sliding table with two food bowls, but out of reach and the way was barred by a stiff net. A rope was looped around the table and one end snaked into each of the paddocks. If either elephant tugged on the rope individually, the entire length would simply whip round into its paddock, depriving both of them of food. So, the job required teamwork.

And the elephants know it. When confronted by this challenge, the elephants learnt to coordinate with their partners. They eventually pulled on the rope ends together to drag the table towards them. The elephants also delayed pulling the rope for up to 45 seconds if the arrival of their partner was delayed which showed that they comprehended that there was no point in pulling on the rope if their partner lacked access to the rope. Even when one individual was released first, they soon learned that tugging on the rope themselves was futile. It's yet more evidence that these giant animals have keen intellects that rival those of chimps and other mental heavyweights.

Experiments such as this have never been done on animals apart from primates before. Plotnik et al. (2011) subjected this experimental paradigm to elephants and have shown that elephants can learn to coordinate with a partner. The elephants learnt that this was the case much more quickly than has been shown in Chimpanzees in other studies.

Plotnik et al. claim that convergent evolution may have lead elephants to have reached a level of cooperative skill equal to that of chimpanzees.

But in reality are humans always helpful and kind to their fellow human beings? When there is an accident how of many of us stop and help, telephone for an ambulance maybe, or offer water to an old man who is perspiring due to the heat, or offer to help a blind man cross a busy road. Of course, these are simple acts of benevolence not requiring taking on criminal elements.

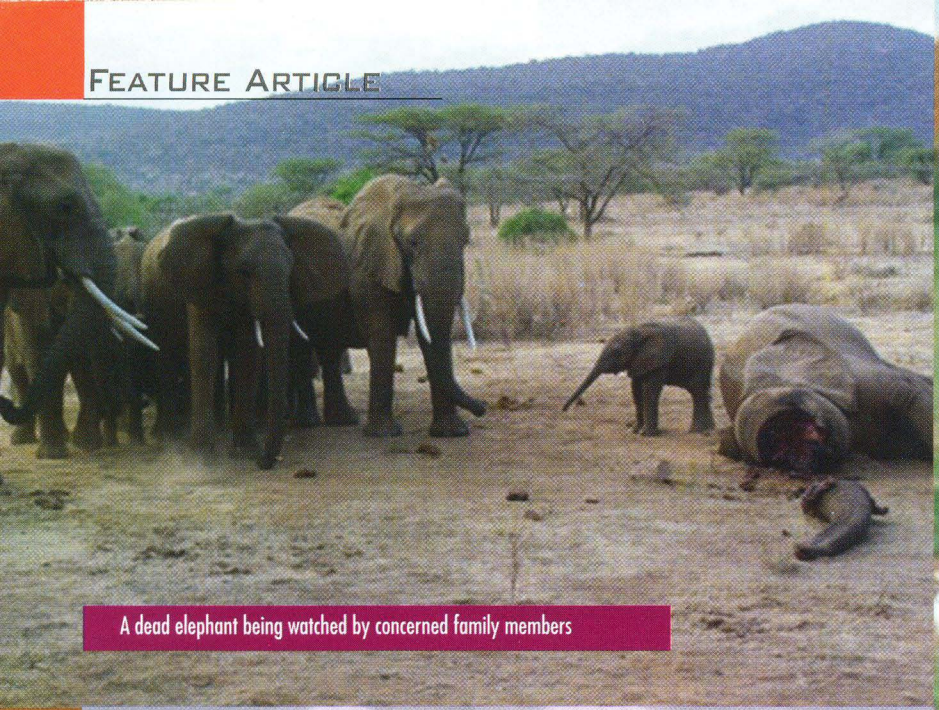
Are there any similar examples in nature? Yes! There are plenty, but let us take the example of an animal that exhibits the highest level of intelligence and integrity—the Elephant.

There are two species of elephants, the *Elephas* and *Loxodonta*. The Asian elephants belong to the species *Elephas* and the African elephants to *Loxodonta*. Whatever may be the species, both groups are intelligent with strong feelings towards members of their group.

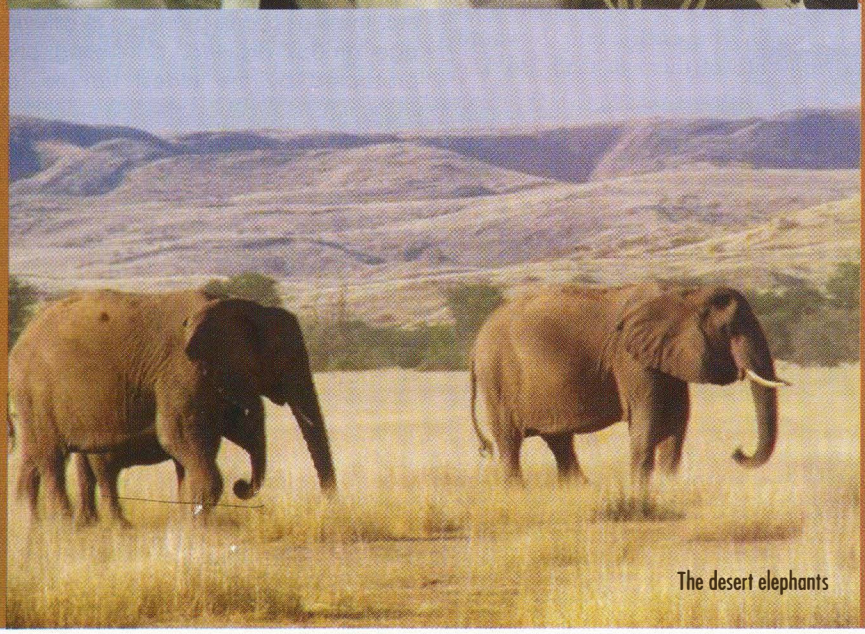
Elephants live in family groups that fit into a particular social pattern. The male and female elephants lead different ways of living. The females spend their entire lives in very close family groups consisting of mothers, daughters, sisters, aunts, cousins, etc. These elephants belonging to different age groups are led, controlled and protected by the eldest female, or matriarch. The male calves, on reaching adulthood, leave the herd and lead solitary lives.

The social obligations of the female elephant do not stop with looking after her immediate family group. She has to protect the young females in her group from the wandering solitary bulls. She also interacts with other families, groups and sub-populations and communicates with all of them regarding the availability of water, sighting of predators like lions, etc.

Most family groups consist of some five to fifteen adults, as well as a good number of immature males and females. When a group gets too big, a few of the adult daughter elephants will move off and form their own family groups. Elephants being



A dead elephant being watched by concerned family members



The desert elephants

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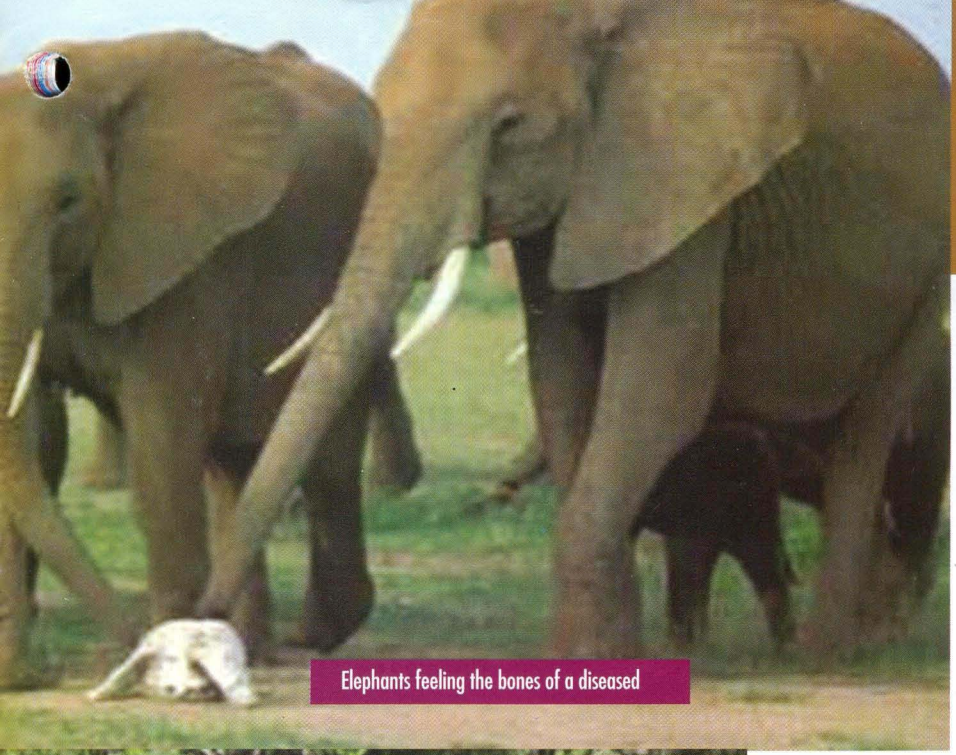
The male calves, on reaching adulthood, leave the herd and lead solitary lives.

Ultimately, the young adult males start forming their own bachelor herds.



Elephants feeling the bones of a diseased

Elephants communicating

very intelligent and with sharp memory know which among the nearby herds are relatives and which are not.

As the juvenile male reaches adulthood, he starts to spend more time with his peer group in the herd, or to remain solitary and stay away from the herd for a few hours a day. Ultimately, the young adult males start forming their own bachelor herds.

Only on attaining sexual maturity an adult male will approach a female in a herd. According to observations, even during the mast season, when two bulls compete for a female their fighting will look ferocious and frightening, but in reality they inflict very little injury on each other it seems.

A program on *Discovery* channel revealed a very touching aspect of elephant behavior. An adult female elephant has an injured foot and so she cannot walk as fast as the rest of the herd. The herd is in the middle of a dry patch of forest and is hurrying towards a water source.

The injured female halts and her sister, daughters and one

Elephants being very intelligent and with sharp memory know which among the nearby herds are relatives and which are not

of her cousins also stop moving and wait for her to regain her energy. It takes nearly two days for these elephants to rejoin their herd. They are so many hours behind the herd still they wait for their relative to get better and rejoin the herd.

If a baby elephant gets into trouble all the female relatives will gather and rescue it. Even in feeding the babies, all mothers share the responsibility.

Elephants exhibit remarkable degrees of dignity. In the African jungles, there are places that serve as graveyards of old and sick elephants. When such elephants feel that they are of no use to the herd and could prove to be an impediment or feel that they are about to die, they reach these places and slowly die with great dignity.

When a herd passes a place where they find the bony remains of a dead elephant, the members stand solemnly and each elephant gently lifts a bony remain, feels it with its trunk, places it down and then trumpets. The sound is softer, very much different from the loud bellowing and expresses the sorrow felt for the demised. The scene is very much like a condolence meeting held by humans.

The Namibian desert elephants are a separate group of elephants adapted to extremely dry conditions prevailing in the region. They are smaller in size than the rest of the African elephants and withstand water scarcity and food shortage with great endurance. Such a herd is led by the matriarch through hundreds of kilometers of scotching desert, safely to a waterhole.

Elephants have remarkable abilities of communicating over long distances by producing and receiving low-frequency sound (infrasound). Actually, these are sub-sonic rumblings that can travel in the air and through the ground much farther than higher frequencies. These rumblings are of different kinds and are not audible to human ear. Through these sounds, elephant herds communicate with each other regarding potential dangers, occurrence of water sources and prowling predators.

Elephants have great degrees of endurance and loyalty. Otherwise why do they endure the tortures inflicted by their mahouts? With their tremendous energy and massive size they can easily inflict mortal injuries every day on the people who handle them. But they do not do so. Only when things go beyond a limit, they attack the mahout.

Let us not consider ourselves the most superior of Nature's creations. There is a lot to be learnt from our fellow inhabitants of this beautiful planet.

Ms R. Vathsala is a biology teacher with more than 30 years of experience in the field of education. At present she is working as an Educational Consultant and Quality Controller in a software firm producing educational CDs for school children. Address: No. 45, II Main Road, Sri Venkatasubramaniya Nagar, Valasaravakkam, Chennai-600087

DEVENDRA DUSANE

Listen to Bacteria Talk!

Bacterial communication opens up new avenues in managing environmental and medical related problems. Let's try to decode the language of these tiny creatures and find out whether they are our friends or foe.

Do bacteria talk?

Yes, they do!

Which language do they speak?

Unlike the language of humans, bacteria use chemical signaling molecules to communicate. These diffusible chemical signals are termed as auto-inducers. Many microbes use this type of cell-to-cell communication called quorum sensing (QS). The QS molecules are released into the environment and are sensed by other bacteria of the same or different species. They are said to coordinate population activities. Scientists are interested to know more about these chemical signals and are trying to decode them.

What is the nature of talk?

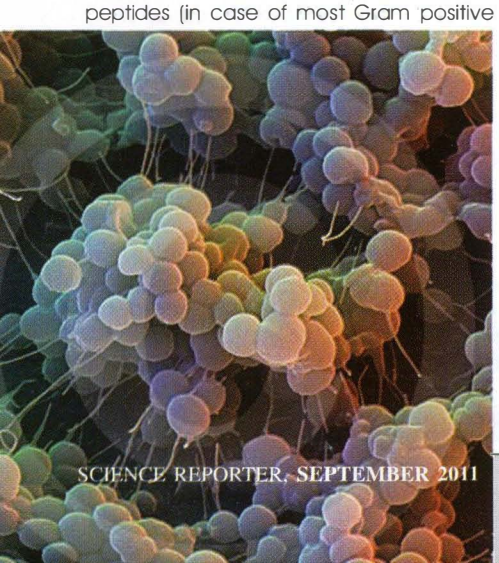
The bacterial cell-to-cell communication is possible chemically by means of peptides (in case of most Gram positive bacteria) and N-acyl homoserine lactones, AHLs (in case of Gram negative bacteria). At higher cell concentrations bacteria use these chemical signals to switch from a nomadic existence to that of a multicellular community normally termed as biofilms. The accumulation of signaling molecules enables the cells to sense the number of bacteria and in turn controls the cell density. In natural surroundings, there are many different bacteria living together that use various classes of signaling molecules. As they employ different languages, they cannot necessarily talk to all other bacteria.

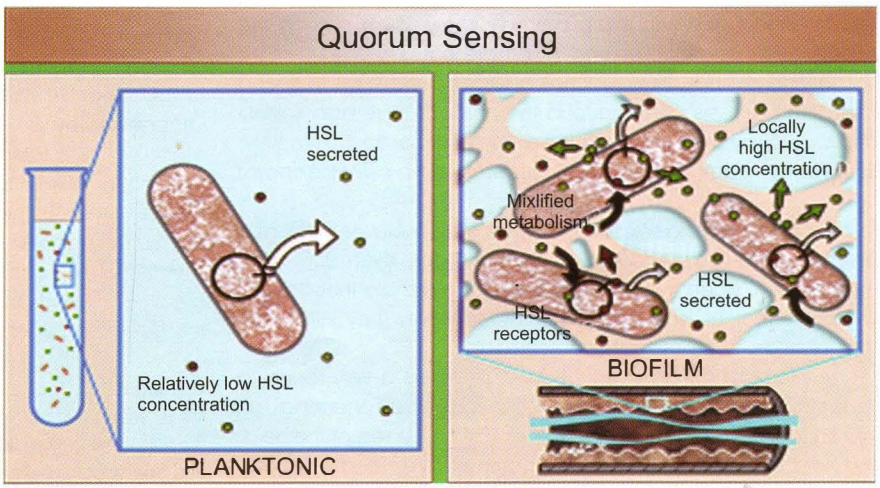
Why do they talk?

In natural environments, bacteria need to adapt to changes in nutrient availability, competition, limited living space and other toxicants, or to fight the immune response of the host where they colonize. These tiny creatures need to communicate and coordinate in order to overcome these problems. The important processes related to production of virulence factors and antimicrobial resistance in case of pathogenic bacteria have been credited to quorum sensing. Quorum sensing plays an important part in the formation of biofilms.

What are biofilms?

Microbial cells are always in the form of complex multicellular communities. These surface-attached (sessile) microbial communities are termed as "biofilms". They thrive on environmental settings such as





Mechanism of quorum sensing illustrated. HSL is Homoserine Lactone, a quorum-sensing molecule.
Courtesy: P. Dirckx, MSU Center for Biofilm Engineering.

A single species can have more than one quorum sensing system.

cooling towers, heat exchanger surfaces and are credited with most corrosion-related problems. They are also present on various medical settings such as catheter surfaces, prosthetic devices etc. In medical and environment related problems they are sanctified with the powers of higher resistance towards antimicrobials, metals and other disinfecting agents. They usually form an unavoidable part of the system with which they associate and this property makes them a nasty personality in the microbial world. Biofilm growth and bio-fouling are global problems causing tremendous economic problems in medicine and industry.

In biofilms too interestingly there is a talk in between the communities. The talk in case of pathogenic communities is focused more towards initial adherence, formation of multicellular structures and to establish pathogenesis for disease condition spread.

Whom do they talk to?

The bacteria talk to bacteria from same species and to bacteria from different species as well. The talk between different bacterial species is normally termed as "quorum sensing cross talk". It is also observed that different bacteria use different quorum sensing molecules to communicate. A single species can have more than one quorum sensing system and the bacteria might respond to each molecule in a different fashion.

Are there any standard quorum sensing bacterial systems?

The production of these chemical signals or quorum sensing molecules has typically been checked by bacteriological monitor systems. The characteristics of bacterial systems most commonly used are:

Pigment production: *Chromobacterium violaceum* is the most commonly studied bacteria for quorum sensing. It is a soil-borne Gram-negative bacterium. The indication shown by this bacterium is the production of a pigment violacein when its reacts with a quorum sensing auto-inducer molecule, N-hexanoyl homoserine lactone (HHL). The HHL is released into the environment and diffuses back into the bacterium when quorum sensing has been reached. This bacterium is studied with respect to many industrial and pharmaceutical perspectives.

Bioluminescence: *Vibrio fischeri* is another bacterium used for quorum sensing studies. It is a marine bioluminescent bacterium, produces light only when large numbers of bacteria are present. The luminescence was initiated by the accumulation of auto-inducer in the medium. In this case the mechanism of cell density sensing was observed for producing luminescence.

Antibiotic production: *Erwinia carotovora* is a bacterium known to produce antibiotic as a result of quorum sensing. A class of mutant could not make antibiotic on its own but could do so when cross-fed by a second group of mutants. It was observed that the second type was supplying a signaling molecule, which triggered antibiotic synthesis in the first group.

Enzyme production: *Pseudomonas aeruginosa* is a Gram-negative bacterium known to be a human pathogen. It shows similar quorum sensing system as *V. fischeri.* It is shown to regulate the production of an important virulence factor such as the production of an enzyme elastase.

Why is this study necessary?

In accordance with the interfering mechanisms and properties posed by controlling the talk or cross talk, most of the diseases can be controlled. By use of mediators that might help disrupt the talk, most of the communications in between these bacteria can be curbed. The initial work in this field was more focused on the symbiosis and pathogenesis as well as the AHL regulation of traits required for the symbiosis or virulence. Recent research has been more focused on the broad range of bacteria looking at their phenotypic expressions like production of anti-fungal compounds, swarming behavior, biofilm formation and production of extra-cellular polysaccharides. Researchers have shown the use of quorum sensing molecules to increase fermentation yields.

There is a continuous search for potential quorum sensing inhibiting agents in case of pathogenic and detrimental bacteria and hence a need to know more about their communication signaling molecules.

What are quorum-sensing inhibitors?

The quorum-sensing inhibitors are similar to AHL molecules that are generally used to inhibit the bacterial talk and disrupt biofilms. Quorum sensing inhibition may represent a natural, widespread, antimicrobial strategy utilized by plants and other organisms with significant impact on biofilm formation. Quorum signaling is now recognized as a global regulatory mechanism in bacteria which in some human and plant pathogens such as *Pseudomonas aeruginosa* and *Erwinia carotovora* has been shown to regulate virulence. Some of the representative agents that show inhibition of bacterial talk are:

Antibiotics: Agents belonging to the macrolide group of antibiotics such as Azithromycin have been shown to disrupt quorum sensing in *Pseudomonas aeruginosa,* a major causative agent of cystic fibrosis in humans. The antibiotic disrupts communication in *Pseudomonas* as Azithromycin acts as antagonist inhibiting the QS and in turn reducing the biofilm formation.

Medicinal Plants: Researchers have suggested the use of vanilla seed extracts for the disruption of quorum sensing in *P. aeruginosa* biofilms.

Marine systems: A marine seaweed, *Delisea pulchra,* produces a number of halogenated furanones and enones that interfere with the formation of biofilms by inhibiting the talk between bacterial systems. Since the halogens produced cannot be suited to human systems, there are efforts for search of other natural quorum sensing inhibitors. Researchers say that chemical signaling controls the behavior of biofilms. They have begun to manipulate both biofilm formation and detachment of the biofilms using these signals and their analogues.

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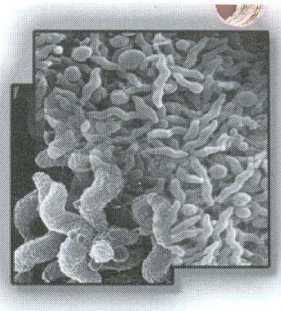
Microbes in your Body!

RAKESH MOHAN HALLEN



Do we each have distinct microbial signatures at birth, or do they evolve as we age? And how much do they matter?

WITHIN the body of a healthy adult, microbial cells are estimated to outnumber human cells by a factor of ten to one. These communities, however, remain largely unstudied, leaving almost entirely unknown their influence upon human development, psychology, physiology, immunity, and nutrition. To take advantage of the recent technological advances and to develop new ones, the National Institutes of Health, Bethesda, USA has initiated a research initiative termed as the Human Microbiome Project (HMP). Its mission is to generate resources enabling comprehensive characterization of the human microbiota and analysis of its role in human health and disease.

Traditional microbiology has focused on the study of individual species as isolated units. However many, if not most, have never been successfully isolated as viable specimens for analysis, presumably because their growth is dependent upon a specific microenvironment that has not been, or cannot be, reproduced experimentally. Among those species that have been isolated, analyses of genetic makeup, gene expression patterns, and metabolic physiologies have rarely extended to inter-species interactions or microbe-host interactions.

Advances in DNA sequencing technologies have created a new field of research, called metagenomics, allowing comprehensive examination of microbial communities, even those comprised of uncultivable organisms. Instead of examining the genome of an individual bacterial strain that has been grown in a laboratory, the metagenomic approach allows analysis of genetic material derived from complete microbial communities harvested from natural environments. In the HMP, ,this method will complement genetic analyses of known isolated strains, providing unprecedented information about the complexity of human microbial communities.

By leveraging both the metagenomic and traditional approach to genomic DNA sequencing, the Human Microbiome Project will lay the foundation for further studies of human-associated microbial communities. Broadly, the project has set the following goals:

- Determining whether individuals share a core human microbiome
- Understanding whether changes in the human microbiome can be correlated with changes in human health
- Developing the new technological and bioinformatic tools needed to support these goals, and
- Addressing the ethical, legal and social implications raised by human microbiome research.

Notably, however, the utility of the techniques and technologies pioneered by the HMP will not be limited to studies of human health but will be applicable to the study of microbes in a wide range of biological processes. Microbes profoundly shape this planet and all life on it, and yet the test tube of the laboratory is rarely reflective of how they actually exist in the environment. The ability to study native microbial communities represents a fundamental shift in microbiology and is one whose implications can only be imagined.

The Gut Microbiome

The human gut is sterile at birth. Immediately after birth, it is colonized by numerous types of microorganisms. Some of these microorganisms enter the body through air that is breathed in, some through water, food and still others through contact with persons around and objects surrounding the person at different stages of life. In the first weeks of life, tremendous temporal and inter-individual variation is evident in the infant's microbial populations (microbiome). By 1 year of age, while babies retain their unique bacterial profiles, these converge toward a profile characteristic of the adult individual gastrointestinal tract (Palmer et al., 2007).

While significant changes may occur during disease, infections, stress, and depending on the diet in the intestinal microbiome, this tends to revert to that which was established in infancy if the external factors change. Traditional methods that rely on the isolation of microbes in culture, although invaluable to clinical microbiology, cannot address ecological questions because of the complexity of intestinal microbial communities. Indeed, by far the majority of these microbes are not readily cultured and are generally referred to as 'unculturable.'

Recent advances in molecular-based technologies, however, now permit genetic analysis of complex microbial populations without the need for cultivation. As a result, gut microbiota have now been estimated to consist of at least 1800 genera and up to 40,000 species of bacteria based on the analysis of 16S ribosomal RNA. They have an estimated mass of 1–2 kg, number 100 trillion (Frank and Pace, 2008) and together possess 100 times the number of genes in the human genome (Kurokawa et al., 2007). Now that the human and many animal genomes have been unraveled, a significant worldwide effort is being invested in the characterization of the human microbiome ([Kinross et al., 2008] and [Turnbaugh et al., 2007]).

Human Microbiome Project's mission is to generate resources enabling comprehensive characterization of the human microbiota and analysis of its role in human health and disease.

While a limited number of metagenomic analyses of the human gut microbiome have been published already, much still needs to be done before we can compare individual analyses, or better still, look for abnormal patterns in disease. It should also be emphasized that almost all the work done so far in this area comes from analysis of fecal (and therefore largely colonic) samples, and very little information exists on the microbial content of the small intestine where considerable microbe-host biological interaction occurs.

Microbiota and Animal Behaviour

The idea that the composition of bacteria present in the intestines of a person may affect mood and behaviour is supported by a series of several published scientific studies. For example, *Campylobacter jejuni* infection increases anxiety-like behaviour in the holeboard: It has been shown that orally administered *Campylobacter jejuni*, in subclinical doses too low to elicit overt immune activation, result in anxiety-like behaviour in mice. It is also reported that areas of brainstem activation, such as the nucleus tractus solitarius and lateral parabrachial nucleus, participate, presumably via the vaug nerve pathway; in neural information processing that ultimately lead to autonomic, neuroendocrine and behavioural responses. These types of experiments all support the suggestion that the gut microbiome may be intimately involved in the modulation not only of the peripheral but also aspects of the central nervous system including behaviour.

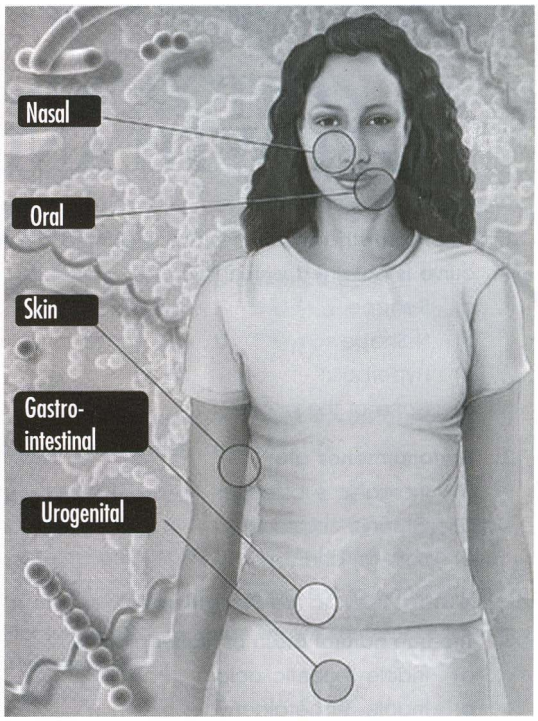
The intestinal microbial balance may also be temporarily changed by an alteration in diet and the effects of the latter upon cognition and behaviour are well recognized. A recent study showed that a specific dietary manipulation positively affected memory and reduced anxiety-like behaviour. These changes were associated with significant increases in diversity of the microbiome as analyzed by the most up-to-date molecular methodology—pyrosequencing.

The human host and its microbial flora constitute a complex ecosystem whose equilibrium serves as a remarkable example of reciprocal adaptation. Intestinal bacteria play an important role in the development of the immune system. The normal intestinal flora is responsible for resistance to colonization by exogenous pathogenic microorganisms. Nevertheless, it also constitutes a reservoir of potentially pathogenic bacteria in close contact with the host. These bacteria are responsible for opportunistic infections in immunocompromised hosts. The equilibrium of the flora can be upset by antibiotics, leading to infections as a result of proliferation of antibiotic-resistant pathogenic bacteria.

There is a greater diversity of bacteria living on the human forearm than on any other part of the body, according to a new study. On average, 44 different types of bacteria reside on the forearm, compared with 19 species living behind the ear, says the study by the National Human Genome Research Institute in the US. Reporting the results of the study, *ScienceNow*, a science journal, said: "Microbes that live *in* and *on* our bodies outnumber our own cells ten to one." Intriguingly, these microscopic passengers were found to be evenly distributed around the body.

In broad terms, research has revealed that a far wider variety of bacteria live on our skin than was previously believed. It also showed that dry and moist skin had a broader variety of microbes than oily skin. Scientists have developed an atlas of the bacteria that live in different regions of the human body.

Some of the microbes help keep us healthy by playing a key role in physiological functions. The University of Colorado at Boulder team found unexpectedly wide variations in bacterial communities from person to person. Researchers hope their work, published in *Science Express*, will eventually aid clinical research. They say that it might one day be possible to identify sites on the human body where transplants of specific microbes could benefit health.



This study was based on an intensive analysis of the bacteria found at 27 separate sites on the bodies of nine healthy volunteers. Not only did the bacterial communities vary from person to person, they also varied considerably from one site on the body to another, and from test to test – but some patterns did emerge. They used the latest gene sequencing and computer techniques to draw up a profile of the microbes found at each specific site. Most sites showed big variations in the bacteria they harboured from test to test even within the same individual. However, there was less variation in the bacteria found in the armpits and soles of the feet – possibly because they provide a dark, moist environment.

The least variation of all was found in the mouth cavity. Skin sites in the head area, including the forehead, nose, ear and hair, were dominated by one specific type of bacterium. Sites on the trunk and legs were dominated by a different group.

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SANJEEB KUMAR DAS

GROWTH AND GROWTH HORMONE

1. **When growth rate of a plant is plotted against time, a curve is obtained which is:**
   a) S-shape
   b) N-Shape
   c) Hyperbolic
   d) None of the above

2. **Phytohormones are:**
   a) Inorganic substances
   b) Organic substances
   c) Both (a) and (b)
   d) None of the above

3. **The true natural auxin of higher plant is:**
   a) Indole-3-acetic acid
   b) Indole-3-acetaldehyde
   c) Indole-3-pyruvic acid
   d) Indole-3-acetonitrile

4. **Transport of auxin in plant is predominantly:**
   a) Polar
   b) Non-polar
   c) Lateral
   d) None of the above

5. **The fungus *Gibberella fujikuroi* causes backanae disease in:**
   a) Rice seedlings
   b) Maize seedlings
   c) Wheat seedlings
   d) None of the above

6. **Which of the following is not a specific physiological effect of gibberellins:**
   a) Elongation of internode
   b) Bolting and flowering
   c) De novo synthesis of I-amylase
   d) None of the above

7. **Fruit ripening hormone is:**
   a) Ethylene
   b) Auxin
   c) Kinetin
   c) All of above

8. **Traumatic acid is sometimes known as:**
   a) Floral hormone
   b) Wound hormone
   c) Natural plant growth inhibitor
   d) None of the above

9. **Most important biological effect of kinetin in plants is to induce:**
   a) Cell enlargement
   b) Cell division
   c) Elongation of internodes
   d) None of the above

10. **Deteriorative processes that naturally terminate functional life of the plant are called:**
    a) Ageing
    b) Senescence
    c) Abscission
    e) None of the above

11. **Which of the following is considered as naturally occurring growth inhibitor in plants?**
    a) IAA
    b) ABA
    c) GAI
    e) All of above

12. **Which one of the following is a potent weed killer:**
    a) 2,4-D
    b) IAA
    c) TIBA
    d) NPA

13. **The primary hormone causing abscission of leaves is:**
    a) ABA
    b) IAA
    c) Ethylene
    d) Cytokinin

14. **Measurement of growth can be done by old method using:**
    a) Horizontal microscope
    b) Arc auxanometer
    c) Pffefer's auxanometer
    d) All of above

15. **Overall senescence is typical of:**
    a) Annual plants
    b) Perennial plants
    c) Deciduous plants
    d) All of above

ANSWERS:

1. a	2. b	3. a	4. a	5. a	6. d	7. a	8. b
9. b	10. b	11. b	12. a	13. c	14. d	15. a	

Contributed by Sanjeeb Kumar Das, Department of Botany, Regional Institute of Education, Acharayavihar, Bhubaneswar-751022 (Orissa)

JAGDISH VALECHA

POLYMERASE CHAIN REACTION

1. **PCR is used to:**
   a. make more copies of DNA
   b. make more copies of proteins
   c. make more copies of RNA
   d. recycle DNA using thermocyclers

2. **Taq polymerase starts copying from:**
   a. DNA primers attached to the end of the desired gene
   b. any open point
   c. the end of free single-stranded RNA
   d. RNA primers attached to the end of the desired gene

3. **A PCR cycle comprises of which of the following series of steps:**
   a. Annealing, cooling, polymerization
   b. Decontamination, excision, amplification
   c. Transcription, Translation, expression
   d. Denaturation, annealing, extension

4. **PCR was discovered by:**
   a. Sir Alec Jeffery b. Kary Mullis
   c. Louis Pasteur d. Robert Koch

5. **PCR can be described as:**
   a. *In vitro* Replication b. *In vivo* Replication
   c. *In situ* Replication d. Translation

6. **PCR amplifies molecular products in which of the following fashion:**
   a. Linear b. Random
   c. Exponential d. Logarithmic

7. **Which of the following is not necessary for the successful completion of the PCR process?**
   a. Taq polymerase b. Oligonucleotide primers
   c. DNA sample d. DNA ligase

8. **In the PCR process, 'annealing' refers to:**
   a. The stage where oligonucleotide primers bind to target DNA
   b. The stage where Taq polymerase starts synthesis of DNA
   c. The stage after elongation but before denaturation
   d. None of the above

9. **Primers:**
   a. Stabilize double stranded DNA
   b. Are long strings of nucleotides
   c. Are enzymes that catalyze the copying process
   d. Are short single stranded DNA fragments

10. **Why is real time PCR better than regular PCR?**
    a. It's better because it has a computer
    b. It is faster
    c. It has reliable quantitation of PCR products
    d. Regular PCR can not get true quantitative results

11. **PCR is carried out in:**
    a. Thermal cycler b. Autoclave
    c. Laminar air flow d. All of the above

12. **Taq polymerase enzyme is obtained from:**
    a. *Thermus thermophilus* b. *Thermus aquaticus*
    c. *Escherichia coli* d. *Thermus oshimai*

13. **PCR is used in:**
    a. Forensic medicine b. Diagnosis of cancer
    c. Phylogenetic studies d. All of the above

14. **RT-PCR is also known as:**
    a. Real Time PCR b. Reverse Transcription PCR
    c. Real Termination PCR d. None of the above

15. **Which of the following types of PCR carries out amplification of DNA of the unknown sequences from the known sequences?**
    a. Nested PCR b. Inverse PCR
    c. Anchored PCR d. Asymmetric PCR

16. **Which of the following PCR types makes use of fluorescent dye?**
    a. Reverse Transcription PCR
    b. Quantitative Real time PCR
    c. Anchored PCR
    d. Nested PCR

17. **The 'Denaturation' stage in PCR is carried out at:**
    a. 95°C b. 20°C
    c. 0°C d. 17°C

18. **PCR was developed in the year:**
    a. 2000 b. 1920
    c. 1995 d. 1983

19. **Which of the following PCR types is used in the amplification of RNA molecules?**
    a. Arbitrarily Primed PCR
    b. Real Time PCR
    c. Reverse Transcription PCR
    d. All of the above

20. **In PCR, Bovine serum albumin (BSA) is used to:**
    a. Increase the speed of PCR
    b. Protect the enzyme DNA polymerase
    c. It has no role
    d. Increases the specificity of primers

ANSWERS:

1) a	2) a	3) d	4) b	5) a	6) c	7) d	8) a
9) d	10) c	11) a	12) b	13) d	14) b	15) b	16) b
17) a	18) d	19) c	20) b				

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A Veteran of the Documentary Movement in India

Dr. S. Krishnaswamy

Documentary filmmaker, producer, director and writer Padmashri Dr S. Krishnaswamy has produced a series of remarkable educational and science films over the past five decades. After studying film and television at Columbia University, New York, he collaborated with Prof Erik Barnouw and wrote the acclaimed *Indian Film* (Columbia University Press 1963 & Oxford University Press 1980). Soon after, he founded Krishnaswamy Associates in 1964. In a career spanning 45 years he has made over 400 short films. He has addressed several international conferences around the globe and has held several honorary positions in international film festivals.

In 1974, he launched his ambitious film "Indus Valley to Indira Gandhi" acquired by Warner Bros for worldwide distribution. To celebrate the Golden Jubilee of Indian independence, he made "India 5555" – a documentary on 5 millennia of civilisational values, 5 centuries of recent history, 5 decades of democracy, and 5 years of a new economic policy. It was chosen by the White House and screened for President Bill Clinton who was preparing for his visit to India.

He has won four National Awards for his short films, and many prestigious international awards. In 2005, he received the coveted "Life Time Achievement Award" conferred by the US International Film & Video Festival, Los Angeles, and became the first Afro-Asian recipient of this honour in 40 years.

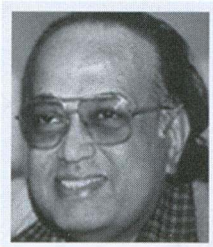
Er Anuj Sinha, Director, Vigyan Prasar and Consultant, Department of Science & Technology, Govt. of India talked to **Dr. S. Krishnaswamy** about his contributions to documentary making, challenges in science communication through electronic media, and other developmental aspects. Here are excerpts of the interaction.

Er Anuj Sinha: You have worked in science outreach extensively. What has been your motivation and do you feel satisfied with the change in the attitude of the common man?

Dr S. Krishnaswamy: My first experience with science outreach was in the late 1960s. Mr. Umesh Rao, legendary Art Director of J. Walter Thomson, and creator of Air India's Maharaja Mascot once said, "Krishnaswamy has green fingers with agricultural films." We made promotional films, educational films and training films related to modern agriculture – hybrid seeds, use of fertilisers, etc. Several thousands of 35-mm prints were made supporting different brands of agricultural input products distributed throughout the country. I took whirlwind tours of villages in South India to study the impact of these films. It was most revealing and immensely satisfying to realise that we were among the instruments of change in the green revolution.

Madras Fertilisers Ltd, which at that point in time was the largest fertiliser manufacturing company, found that their product was more identified with the puppet character that we had created in our ad-films and documentaries, than with the name of their company. Hence, they adopted the puppet as their monogram and the name of the puppet character, "Vijay", as the brand name of their product itself.

We made a film on technology-transfer from Lab-to-Industry for CSIR, some 25 years ago. We produced over fifty programmes on Home Science, anchored by my daughter Lata, with the cooperation



We made a film on technology-transfer from Lab-to-Industry for CSIR, some 25 years ago. We produced over fifty programmes on Home Science, anchored by my daughter Lata,.

of the Avinasalingam Home Science College, Coimbatore.

We have dabbled in medical education films, engineering education films and a whole spectrum of science education for the classroom or for in-house training of specific industries. Our film on how the Bahai Temple in Delhi was built, filmed from a 'building technology' point of view, for Larsen & Toubro, was ranked as the best film on Construction Technology at an International Conference of Builders. The colleges and training institutions, which have used these different films, have given excellent feedback on their popularity with their students.

The most recent and highly satisfying science serial in Tamil aimed at the teenage audience is 'Ariviyal Aruvi' (loosely translated as "Shower of Science"), directed by Lata and produced by Dr. Mohana. A state-level conference and seminar in which teenagers from all over Tamilnadu participated exclusively to discuss this serial, produced immensely gratifying results by way of enthusiasm around the serial.

Er Anuj Sinha: How do you see the emerging future of TV as a medium for building interest in science among the audience? What complementary efforts are required to make it more effective?

Dr S. Krishnaswamy: Television as a medium is neutral. It is part of societal responsibility to ensure that it is used productively. Woody Allen said, "Hollywood has invented a unique method of garbage disposal. They simply convert them to television serials." The problem is that with globalisation, this trend has been imported worldwide and India produces as much garbage as anybody else, for television. It remains to be seen whether this greatest challenge for civilisation will be successfully met with wisdom. As a neutral tool, television is capable of imparting science as well as spirituality by those who handle the medium with knowledge and wisdom. The complementary effort required is to ensure that the presentation and packaging of science is exciting, so that it can compete for the attention of the young audience with ephemeral and irrelevant programmes with titillating content.

Er Anuj Sinha: You have introduced a range of innovations on regional and national TV. Please share some of your experiences with our readers.

Dr S. Krishnaswamy: Innovations are mainly of three kinds – the themes tackled, the methodology employed and the technology employed. In terms of the themes, during the first decade of my career, I found the release of documentary films in India was so totally dependent on the Films Division, Govt. of India, which had monopolised the twenty-minute slot given for non-fiction films in the cinemas. I decided to make a feature-length documentary and test the waters by releasing it as a stand-alone programme. Amidst much opposition from well wishers, I launched the project titled 'Indus Valley to Indira Gandhi' in 1973, and completed it in 1976. Narrating the 5,000-year story of India in four hours, shot in 120 locations across the country, I had burnt my boats in producing this. Some laughed derisively, while some sympathised with my commitment to an impractical ideal. Indian film distributors refused to touch the product. Six months later, Warner Bros (Hollywood) took interest and acquired the distribution rights of the film. It proved a run-away hit with the audience – more so in India. The film ran into controversy because of its title. But it had established that without a 'star-cast', a non-fiction film could commercially succeed in a spectacular fashion with audience "buying" tickets to watch a documentary.

Jumping four decades, the most recent, rather ambitious project, Mohana and I have been working on for some years, is on a bunch of three products – 'Indian Imprints', an 18-episode documentary serial telecast on the National Network of *Doordarshan* in 2008; a feature-length documentary titled 'A Different Pilgrimage', completed in 2010 and screened during the Cannes International Film Festival (yet to be released for public exhibition); and 'Tracking Indian Footmarks' – four episodes meant for a global audience. All these three titles trace the impact of ancient India on South-east Asia and we have treated them from different perspectives. These three constitute a pioneering effort to unravel an aspect of history hardly ever tackled – filmed in hundreds of locations in Indonesia, Thailand, Cambodia, Laos and Vietnam, covering monuments, mythology, philosophy and dance forms.

'Indus Valley to Indira Gandhi' was a 35-mm Eastman colour film. For over two decades, we were working on 35-mm film. I evolved a policy of remaining technologically up-to-date by acquiring state-of-the-art cameras. The International Quorum of Film & Video Producers, Washington DC gives membership only by 'invitation' and not by application. Usually there is only one member per region. In the 1980s, the Quorum made me a member representing South Asia. This helped a great deal to keep myself well informed about innovations worldwide and introduce them in our own work, adapting technology to local requirements. Thus we switched over to video production very early. Arguably, our company was the first in India to establish Betacam broadcast-quality equipment. We maintained the lead six years ago by being among the first few to be equipped with digital high quality production in DVCPRO 50.

I introduced 'Chroma key' facility in my studio long before Doordarshan did. It is a technology by which you create illusions of backgrounds. For one of our Tamil TV serials, the newspapers reviewed that it must have been far too expensive to shoot one whole episode in Paris. In fact, it was all shot within our studio creating the illusion of Paris. We used a combination of virtual reality backgrounds and miniature sets while filming the Tamil classics 'Silappadikaram' and 'Manimegalai' as a Hindi serial titled 'Upasana'. The effect was spectacular but the cost affordable. We began with cell animation forty years ago for 35-mm film and have come a long way today with 3D animation with computers. They become handy in films related to science and technology.

Apsara Dancers of Cambodia –a scene from 'Tracking Indian Food'

Er Anuj Sinha: You received higher education in the US and were preparing for a different career. How did you change your trajectory and do you, in retrospect, feel it was worthwhile?

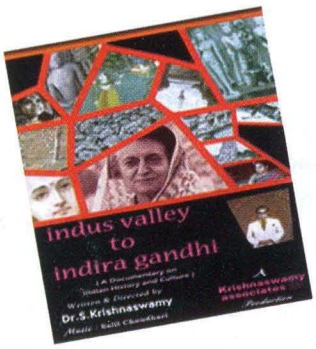
Dr S. Krishnaswamy: After getting my Bachelor's degree in physics from Presidency College, Madras (now Chennai) and learning sound engineering privately, I proceeded to New York to study electronics. When I expressed my desire to do this, my father encouraged me whole-heartedly and financed my initial education in New York, despite the fact that he was not in the best financial circumstances. Within weeks of my arrival in New York, I discovered that Columbia University was offering a Master's programme in Mass Media with special reference to cinema and television. It attracted me a great deal, while the electronics course that I had joined was too elementary for a physics graduate. I met the head of media at Columbia (Prof. Erik Barnouw, with whom I collaborated in writing a book, two years later) and impressed upon him my interest in film and television by giving him a copy of my Thesis on Expression. That meeting with Prof. Barnouw was a turning point, since he became a major influence on me. I have never looked back since.

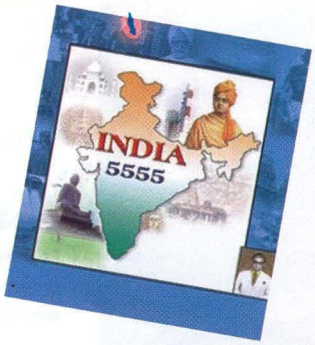
Er Anuj Sinha: Would some other means of expressing creativity have been more satisfying to you?

Dr S. Krishnaswamy: The documentary film has remained my first love for half a century. Of course I have made a lot of fiction material as TV serials and also one tele-film based on fiction. I used to write a regular column in *The Illustrated Weekly of India* in the 1960s. But my preoccupation as a filmmaker did not allow me to continue that. My writing since then has been confined to film scripts, but for occasional articles in the print media. I enjoy film making thoroughly; but I feel I should be devoting more time to write for the print medium. I am satisfied with what I do; but there is an element of dissatisfaction, without which one may perhaps stagnate. I want to write a book again.

Er Anuj Sinha: You have been richly decorated for your work in India and abroad. Which recognition do you prize the most, and why?

Dr S. Krishnaswamy: I value and respect all recognitions from all quarters – local, national and international. However, I will bracket three awards as of special significance – the Padmashri is listed on top of them since this is a national recognition from the Head of State. The Life Time Achievement Award conferred by the US International Film and Video Festival, Los Angeles, is another since I happen to be the first Afro-Asian to receive this in forty years of that festival; and the Honor Summus Award of the Watumull Foundation, Hawaii, to mark the 40th Anniversary of Indian Independence, which they conferred on 40 people from various fields, who contributed to India's development.





About twenty-five years ago, when I was Chairman of the Jury for National Awards For Non-fiction Films, there were only three awards for short films. I found several worthwhile entries that could not be accommodated within those three.

Er Anuj Sinha: You are a voracious reader. What are the books that you are currently reading?

Dr S. Krishnaswamy: Sometimes I read a book cover to cover. At other times, I read three or four books at one time often unrelated in subject matter. I am in the second mood right now. I am reading *Unconditional Life* by Deepak Chopra; besides Steven Levitt and Stephen Dubner's *Freakonomics* that takes an unconventional look at the Western Economy. I am also half way through Jeffrey Archer's *And Thereby Goes a Tale* – his new collection of short stories.

Er Anuj Sinha: What are your current assignments? Where do you find the energy and ideas for new projects despite being in the industry for so long?

Dr S. Krishnaswamy: I am making a compilation of extracts from my father's important, socially relevant films and those that propagated the freedom struggle, with a thread of narration and docudrama re-enacting some aspects of his life – to try and bring out his personality and philosophy as a filmmaker. I am doing the paper work for a long television serial on the life and message of Swami Vivekananda. The active production will commence later this year.

Lata is completing an omnibus documentary titled '5,000 Years In 50 Minutes' to introduce the 'idea of India' in less than one hour, from ancient times to the present day. She is also working on a bunch of films for the Ministry of Panchayati Raj, which are basically training films for new members and office bearers of Village Panchayats. Hopefully, we will launch the second season of Arivial Aruvi (Science Trail), which we made for DST last year.

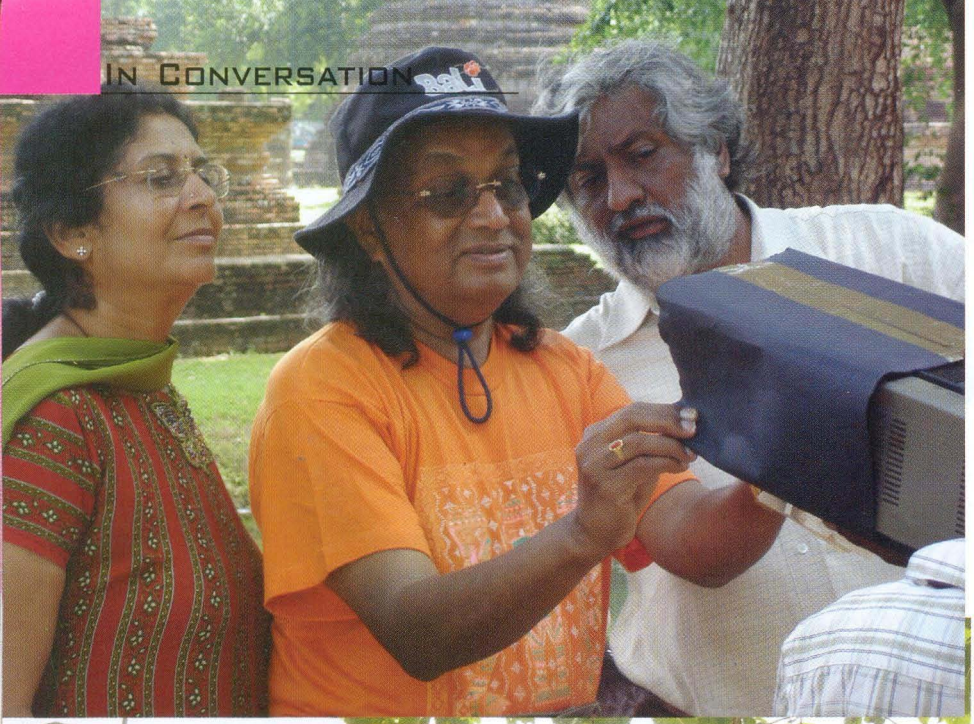
You asked me "where do I find energy and ideas for new projects despite being in the industry for so long?" Let me narrate a story. Photographer William was taking portrait and full figure photographs of the Queen, regularly for half a century. Recently he submitted his portfolio of her new portraits to the Queen. Her Majesty raised her eyebrows and said "Bill! Your photographs are not as nice as they used to be". The photographer humbly replied, "Your Majesty! Perhaps age has caught up with me!".

I am 72, and I try to be active – not with the energy levels of youth, but with no regrets.

Dr. S. Krishnaswamy receiving the PADMASHRI Award from the President

Er Anuj Sinha: Do you see the digital and multimedia making the TV obsolete in the near future? How should science journalists and communicators prepare for a digital revolution?

Dr S. Krishnaswamy: To my way of thinking, no new medium has totally replaced an old one, but has merely captured a segment of the audience. According to Marshall McLuhan, every new medium takes over the ephemeral contents of communication, helping the older medium to mature and cater to a discriminating audience. Much earlier than McLuhan, Wolfgang Riepl (whose theory of media came to be called Reipl's Law) said, "The future merely composts the past...A convergence takes place in the media field, leading to a different way and field of use for the older forms." I believe science communicators should be



Director Dr. S. Krishnaswamy (right) anchoring a scene

prepared to hang on to television in addition to adapting themselves to new media. Coming to thinking of it, new media mainly consist of new distribution avenues, while the production methodology remains largely the same in aesthetic terms.

Er Anuj Sinha: Since you serve on several juries who, in your opinion, are the most promising science filmmakers on the national and the international firmament?

Dr S. Krishnaswamy: It is true that I have served on several juries. It is regrettable that not many science films are entering into competition in the large category of non-fiction films. About twenty-five years ago, when I was Chairman of the Jury for National Awards For Non-fiction Films, there were only three awards for short films. I found several worthwhile entries that could not be accommodated within those three. I recommended to the government eighteen categories of awards for non-fiction films, including science films, agriculture films, biographical films, anthropological films, etc. It was gratifying that my recommendation was implemented from the following year. When I was Chairman of the Jury again seven years later, I had a sense of fulfilment and joy to announce sixteen awards in these categories. I am afraid that in the recent festivals over the last three years where I have been on the Jury, I have not come across many films that can be described as science films. This may be because there are now separate festivals for science films and I have not been associated with them.

Er Anuj Sinha: What positive role can science fiction have on creating excitement and interest in science?

Dr S. Krishnaswamy: Science fiction is a double-edged sword. When it is written by a well-informed scientist with creativity, it is a great boon. Let me give you two examples. In the late 1920s, H.G. Wells's novel on invasion of the Earth by aliens from Mars was produced as a radio play. It resulted in several thousand radio listeners across the cities in America rushing out of their homes in panic thinking that it was Radio News!

In a later decade, Arthur Clarke's *Space Odyssey 2001* was a remarkable piece of science fiction. Clarke was himself an eminent scientist and so he was able to create science fiction that could one day get transformed to near-reality. He conceived, for instance, the idea of artificial satellites to circle the Earth. Scientists translated this fantasy into reality decades later.

However, there is a lot of muck in the guise of science fiction, lacking in scientific possibility and any streak of creativity. Hence in my opinion, science fiction can create excitement provided it is conceived by people who have a basic understanding of scientific concepts.

Er Anuj Sinha: What is the message that you would like to give young science communicators?

Dr S. Krishnaswamy: The tools of communication are evolving with the speed of light. Scientific knowledge is expanding like the universe. It is a challenge for the new generation to be truly well informed on the one hand, and become immensely talented in imaginatively using the tools on the other. However, neither knowledge nor skills can become fruitful without deep commitment. The challenge can be met by meditating on the reality hidden behind the phenomena – with the urge to understand Truth and not to be satisfied with mere Facts.

SHORT FEATURE

Off Season Fruits in Poly-houses

RESHU CHAUDHARY &
R.S. SENGAR

IF you are yearning for your favourite vegetable or fruit that is not available during the season, poly-houses could be the answer to your predicament.

In temperate countries, it is impossible to grow crops in the winter season, unless of course, you grow them in glasshouses. But these glasshouses require more time and money to erect and maintain them. Their durability is also less in comparison to poly-houses. The invention of poly-houses has revolutionised the production of local off-season vegetables, fruits, flowers etc. during the last 5-6 years. This has promoted the trade of plastic as well.

Now, what is a poly-house? A poly-house is generally made of transparent, tight, cheap and flexible polythene. In these houses vegetables and other crops can be grown in any season of the year depending upon their requirement, because temperature and humidity can easily be controlled in poly-houses. Polythene conserves the thermal radiation, which increases the temperature and provides enough energy for the process of photosynthesis.

For the production of vegetables, fruits and flowers, availability of suitable temperature and relative humidity is a must. These conditions are created in a poly-house especially for the production of off-season vegetables and fruits in sufficient quantity. The importance of polyhouse is further enhanced due to the possibility of production of creeper vegetables.

The Poly-house

The poly-houses are constructed with the help of ultraviolet plastic sheets, which last for more than five years. The basic structure is prepared with bamboos or iron pipes. Iron pipe structure is costly but durable than bamboo. The structure is covered with 1501-micron thick plastic sheet.

Generally the length of the poly-house is 25-30 feet and width 4-5 feet. The direction of the poly-house is always East to West, so that the maximum sunshine is available. The house should not be constructed in shade. The size of the poly-house may differ depending on the necessity. And they may be kept cold or hot depending upon the season.

During daytime, the solar energy helps in increasing the temperature of the poly-house. Little energy is lost from the different parts of the poly-house.

Heating is required in the winter season. Generally the solar energy is sufficient to maintain inner temperature of poly-house but some times a micro temperature is required to be supplied to some crops. For this a few methods may be followed:

(i) Constructing a tunnel below the earth of the poly-house.

(ii) Covering the northern wall of the house by jute clothing.

(iii) Covering the entire poly-house with jute cloth during night.

(iv) Fitting a solar energy driven device in the poly-house.

In summer season when the ambient temperature rises above 40° centigrade during day time, cooling of poly-house is required, which may be achieved by the following methods:

(i) Removing the internal air of the poly-house.

(ii) Sucking external air by putting a fan on.

(iii) Installation of coolers on eastern or western wall not only keeps temperature low but maintains proper humidity also.

(iv) The temperature of the poly-house can be controlled by running water-misting machine.

The Poly-house—Where & When?

From the point of view of earning more profits, only such off-season crops should be grown that are being sold at higher prices in the market. Big hotels in cities are mostly in need of off-season vegetables and so is the case with some prosperous people in big cities. In such areas and also in the hill and remote regions where fresh

Heating is required in the winter season. Generally the solar energy is sufficient to maintain inner temperature of poly-house but some times a micro temperature is required to be supplied to some crops.

vegetables are required regularly for meeting out the requirements of security forces, the construction of poly-houses is more lucrative and must.

Crops grown under the poly-house are safe from unfavourable environment and hailstorm, heavy rains or scorching sunshine. They are also saved from birds and other wild animals. The humidity of the poly-house is not adversely affected by evaporation resulting in less requirement of water. In the limited area of the poly-house, insect and pest control is also easy and less expensive.

By adopting the modern technology of polyhouse, the difference in the demand and supply of off-season vegetables and fruits can be minimised. This facilitates maintaining of the quality of the product also.

In the poly-house one can easily grow trees like Lemons, Bananas, Papaya, Strawberry, and Pineapple; flowers like Akas, Corneson, Jakhaira etc. and vegetables like Bottlegourd, Lady finger, Brinjal, Tomatoes, Onion, Peas, Cabbage, Chillies etc.

In regions with excess rains and cold climatic conditions, it is difficult to grow a nursery of crops in the open environment but in poly-houses this can be done without any problem. If the nursery of these crops is grown in poly-houses in the month of December and January it can easily be transplanted in plains as soon as the winter is over. Following this practice early crop of different types of vegetables such as tomatoes, brinjals and cucurbitacae family can be grown in plains to earn more profits. Similarly rainy season nursery of cauliflowers or onion can be grown in August or September in the poly-houses.

The Technique

Crops can be grown in pots or in the soil. For growing various crops, their nursery is grown first.

Before sowing the seeds, rotten manure is filled in polythene bags of 10 x 15 centimetres size, along with equal quantity of soil and sand. Next, water is sprinkled on the bags and seeds are sown in the bags. Small holes are formed in the bags for easy aeration. These bags are kept inside the poly-house till the plants grow to about 10-15 centimetres and are then transferred to pots or earth. These plants should be given manure and water from time to time. Generally disease does not spread, if at all, a little spray may be required. In a period of about one month formation of fruits start.

For earning maximum profit through maximum production from the crops grown in the poly-house, it is not only necessary to pay proper attention to the supply of manure and water to the plants and protect them from disease but their cleanliness and pruning is also very important. Luxuriantly growing tomato crop requires sticking or otherwise their plants will fall on the ground and get spoiled.

The Economics

Keeping in view the initial expenditure incurred on poly-houses, it can be said without any doubt that poly-houses can prove very profitable provided proper crop is grown in them following proper technique and it is supervised properly. Here's a tentative look at the economics involved:

It is obvious from the above account of income and expenditure incurred on the crop that from the second year onward the profit would start rolling in. The G.I. pipe used in the construction of structure of poly-house will last for many years but plastic film will be replaced once in 4-5 years. Keeping in view all these facts an income of rupees 6000/- can be earned every year (in six months) by growing Shimla chilly and kheera in a poly house of 100 square meter (1/40 acre).

The income and expenditure can decrease or increase on the basis of existing market rates in a particular part of the country. If arrangements can be made to cool down the poly-house, then three crops can be grown easily in a year and more profits can be earned.

THE ECONOMICS	
1. Expenditure on the construction of poly-house	**App. Price (Rs.)**
(i) G.I. pipes, nuts bolts, cement, concrete, bricks and wood etc. for erecting the structure	12,000.00
(ii) Plastic film (U.V. standardized)	7,000.00
(iii) Labour	1,000.00
Total	**20.000.00**
2. Expenditure on crop production (Shimla chilly and Kheera from October to March, six months)	
(i) Price of seed (20 gms)	100.00
(ii) Manure and fertilizer	200.00
(iii) Irrigation	100.00
(iv) Crop security sowing to plucking	100.00
(v) Labour from sowing to plucking	1000.00
(vi) Others	200.00
Total	**1700.00**
3. Income	
Shimla chilly 10 qtl (rate Rs. 8/kg)	8000.00
Kheera 10 qtl (rate Rs. 10/kg)	10000.00

Reshu Chaudhary and R.S. Sengar are in the Tissue Culture Lab, College of Biotechnology, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut-250110

Prize Puzzle

JUMBLE WORDS

Can you unscramble these words, all of which are related to science?

1. DMISLAP .....
2. ZENYME .....
3. GIUNF .....
4. CSRCMIOPEO .....
5. HGEAP .....
6. LMYIS .....
7. PSCAULE .....
8. YALRE .....
9. IKSN .....
10. TEMTAR .....
11. RVIUR .....
12. ITTEEVEGVA .....
13. LLLAFAEG .....
14. ARGUS .....
15. ETOPRIN .....

Contributed by Namrata, 79, C.D.A. Colony, Shastri Nagar, Patna-23

There are three prizes of Rs. 500/– each for three correct entries. In case there are a large number of correct entries, the prize winner will be selected through a draw of lots. The decision of the Editor, *Science Reporter*, will be final.

Last date for the entries to reach us: 30-09-2011

Puzzle Corner
Science Reporter
National Institute of Science Communication And
Information Resources, CSIR, Dr. K.S. Krishnan Marg
New Delhi-110012

Your Name : .....

Address : .....

.....

.....Pin Code : .....

Age : .....E-mail : ....Sex : .....

Occupation : ☐ Student ☐ Housewife ☐ Teacher ☐ Professional ☐ Retired ☐ Other

Educational Level: ☐ Primary ☐ Secondary ☐ Graduate ☐ Postgraduate

*Please fill up the questionnaire at the back

*Please note: Now you can even send your answers on a photocopy of this page.

INSTRUMENTS/GADGETS SEARCH

Search for 22 scientific instruments or gadgets in this grid forwards, backwards or even diagonally.

S	I	U	R	A	I	N	G	A	U	G	E	M	E	T	R	E	E
P	U	S	P	E	R	I	S	C	O	P	E	R	O	M	E	T	M
H	Y	R	Z	S	E	G	T	H	E	R	M	O	S	T	A	T	O
E	M	U	E	E	S	C	A	L	A	T	O	R	R	Y	O	R	R
R	H	O	T	T	P	L	A	L	E	V	Y	A	N	J	E	T	S
O	W	Y	O	K	E	T	B	D	V	R	D	O	F	T	H	R	E
M	I	J	G	K	L	M	N	P	O	A	I	M	U	S	E	T	R
E	R	E	V	R	W	X	O	T	R	S	N	P	A	T	B	E	E
T	E	P	F	C	O	D	O	N	I	E	M	O	N	F	D	P	N
E	L	O	I	J	O	M	P	V	A	O	Q	I	M	R	W	O	O
R	E	C	O	R	D	E	E	O	C	M	R	U	O	E	C	C	H
A	S	S	B	E	S	L	M	T	O	P	O	C	S	U	T	S	P
K	S	O	L	E	E	A	T	L	E	P	E	M	R	O	M	E	O
C	O	B	E	T	N	E	O	L	S	R	E	L	G	O	N	L	R
O	B	O	N	Y	T	M	E	K	E	L	V	I	N	Y	O	E	C
L	A	R	D	O	U	T	P	P	E	L	S	O	N	Y	H	T	I
C	E	T	X	T	A	M	A	T	S	A	X	T	A	N	T	P	M
E	R	S	C	O	T	T	R	E	T	E	M	I	N	A	L	P	S

Contributed by Ms Seethadevi Addanki, St. Joseph's Public School, A.G. Palace, Malakpet, Hyderabad-500036.

SOLUTIONS TO PUZZLES PUBLISHED IN THE JULY 2011 ISSUE

PRIZE PUZZLE:

LINK PUZZLE

PUPIL

LIQUID DENSITY

YOLK

MOLLUSCAN SEARCH

1) Chiton
2) Dentalium
3) Patella
4) Xanchus
5) Aplysia
6) Pila
7) Mytilus
8) Solen
9) Oyster
10) Nautilus
11) Cuttlefish
12) Loligo
13) Octopus
14) Pecten
15) Neopilina

THE NAMES OF THE PRIZEWINNERS BASED ON A DRAW OF LOTS FROM AMONG THE CORRECT ENTRIES ARE:

1. **Suman Kumari**
   Military Station, Quarter No. 316/1
   Berhampur, Orissa
2. **Raktim Kalita**
   S/o Mridul Ch. Kalita
   Gaurav Apartments, Block A, Flat A, 4th Floor
   B.R. Path, Beltola, Tiniali-781028
3. **Vishwajit Singh**
   S/o Arun Kumar Singh
   At Janta Bazar (P.N.B.)
   Dist. Saran, Panditpur, Bihar-841224

CONGRATULATIONS ALL THE WINNERS!

It was almost 150 years ago that Pierre Paul Broca carried out pathbreaking researches on the human brain.

Pierre Paul Broca

The Explorer in the Brain's Maze

KOUSHIK ROY

THE human race attains its apex and the most enviable position, in terms of intellect and ingenuity by dint of a small organ, nestled within the skull—the brain. However, quite a few scientists are enterprising enough to delve deeper into the labyrinthine structure of this brain, impregnated with an incredible maze of nerve cells and grey cells. It is quite spectacular to know how all the segments of our almond-shaped brain, like pons, amygdale, hippocampus, cerebellum, cerebrum and thalamus have been astutely masterminding our five senses, psychological prowess, intuitions and wide array of emotions and impulses.

Similarly curious it is to know about the remarkable adaptability and marvellous evolution of our brain, way from the prehistoric Neanderthals, Sinanthropus, Cro-magnon to the contemporary *Homo sapiens*. A century and a half ago, a visionary and persevering French scientist conducted pioneering research to discover the origin and conception of languages in our brain. He was Pierre Paul Broca – a scientist *par excellence* who explored deep inside the maze that is the human brain.

Pierre Paul Broca was born on 28 June 1824 in Sainte-Foy-La-Grande, Bordeaux in France. His father, Benjamin Broca was an eminent physician in the battalion of the French emperor Napoleon Bonaparte. Broca's mother was also a rational lady with a scientific bent of mind because she had been baptised by Martin Luther's radical view of humanist Protestantism. From his parents, a young Broca acquired the essence of multidimensional wisdom that enabled him to exhibit his immaculate expertise in physiological researches, anatomical concepts and in anthropology – the study of the evolution of the human race.

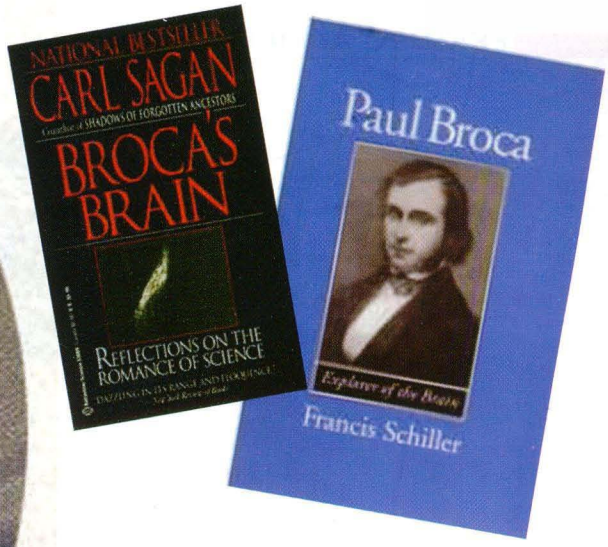
Since his childhood, Broca exposed his ubiquitous genius to the spectrum of literature, mathematics and physics. He graduated with medical science at the raw age of 20. He earned the prestigious diploma – "bachelier des letters" – at the age of 16 only. As a student, Broca was inquisitive enough to gather information about the ancient, scientific researches conducted by Aristotle, Vesalius, Galen, Ibn Sina, Charaka, Hippocrates, Sushruta, William Harvey and other luminaries. Since then, Broca became curious to cruise into the enigma encircling our brain and central nervous system.

But for this Broca needed to acquire a summative knowledge about the human anatomy. He engrossed himself in the study of human anatomical evolution. He began his extensive internship with urologist and dermatologist – Phillippe Ricord at the Hopital du Midi. He was also a junior scientist under the aegis of Dr Francois Leuret. Broca also assisted the renowned French anatomist and surgeon – Pierre Nicolas Gerdy.

Supporting Charles Darwin's scientific theory of evolution, Broca founded a society of radical and logical youth, much akin to Plato's "Akademos" and Henry ouis Vivian Derozio's "Young Bengal" at the age of 24. Despite his persistent conflict with orthodox, exploitative and prejudiced Church authority, Broca remained confident enough to pursue his scientific studies and observations for a greater, philanthropic welfare.

Broca become the youngest faculty of anatomy at the University of Paris medical school. In 1849, he adorned the post of the secretary of the Anatomical Society and was also a doctor of

Being inspired by the pathbreaking researches of Broca, contemporary neurologists like John Hughlings found out that the frontal lobes and the thalamus of our brain also have the capabilities to comprehend and utter words and languages.



Broca had a philanthropic bent of mind also. He supported female education. Like Socrates, Broca was also denounced by the orthodox community as a "corruptor of youth".

medicine. He wanted to mingle psychology, psychiatry and clinical medicine to cure diseased humans. By following that novel avenue, Broca applied hypnotism to anaesthetize patients in surgery. As the professor of clinical surgery, Pierre Paul Broca worked in the Saint Antoine Hospital, Hotel des clinques and in the Necker Hospotal.

Broca realized that to make his study more concretised within the formation and function of brain, as well as to diagnose the causes of several neural maladies, he must have to study the evolution of the human brain. He founded the Anthropological Society in Paris, in 1859, which was the world's first anthropological foundation. Broca also published a journal on the descent of mankind – *Revued Anthropoligie*.

Actually, Broca was more riveted to anthropological quest after going through the works of Isidore Geoffrey-Saint Hilaire, Antoine Etienne Reynaud, Augustin Serres and Jean-Louis-Armand Quatrefages de Breau –notable anthropologists of those times. Broca intensely studied the fossilized bones of our ancestral anthropoids or hominids – Driopithecus, Ramapithecus, Peking man, *Homo habilis* and Australopithecus Boisei. He strongly believed that there must be a direct nexus between the human intelligence and the sizes of brain, as well as cranium (skull).

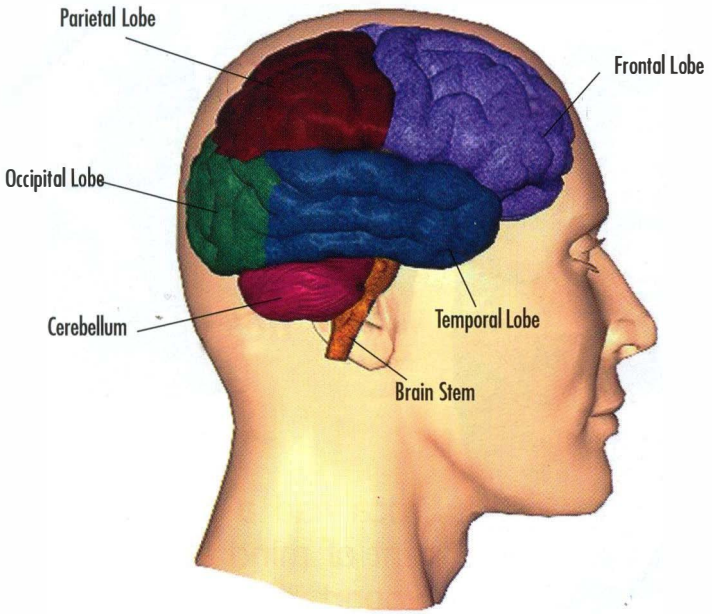
However, Broca never supported the prevalent view that white skinned people or Caucasians are endowed with the best of intelligence. In his humanist viewpoint, Broca always trusted that the gift of intelligence, innovation and ready wit are found liberally within every human, irrespective of social status, caste and creed. It was Broca who calculated that the skull and bone of Neanderthal man, excavated in 1856, were one of the earliest remains of human's ancestry, not an instance of disfigured primate.

He critically evaluated an ancient skull of an Inca tribal, found in Peru's valley of Yucay by archaeologist Ephraim George Squier. He showed the other scientists that the skull was the testimony of an advanced, cranial surgery which used to be carried out during the reign of the Inca emperor Atahualpa, in Peru, Bolivia, Mexico, Ecuador, Colombia, Guatemala and Honduras.

April 1861 will forever remain etched as a milestone in the field of brain research. During this month, Paul Broca conducted a post-mortem or a dissection in the corpse of an imbecile person called "Tan". He called that lunatic by that quaint name because he could not utter any other word except that one, due to his defect in speech. By dint of post-mortem, Broca discovered a unique fact. The frontal lobe of Tan's brain (real name Albert Loborgne) was found completely shrunken, devoid of intelligence-triggering grey cells and was degenerated.

Then, Broca propounded his legendary theory about the function of brain – the left cerebrum of the human brain (which is renamed as Broca's Area) contains the capacity center to make and understand our languages and speeches. The power of impulses, thoughts, physical movements and memory are placed in the other lobes of our brain. By that post-mortem autopsy on Tan's brain at Bicetre Hospital, Paul Broca found out that the eccentric man had been suffering from a terrible nervous disorder called 'Aphasia' (defect of speechmaking and conception of languages, owing to injury in the left cerebral hemisphere of our brain).

By probing into the autopsy report of Tan's brain, Broca found that Tan's brain had developed a scar, or a lesion, which had been caused by syphilis. It is true, that another French neurologist Marc Dax had



Quite a few scientists are enterprising enough to delve deeper into the labyrinthine structure of this brain, impregnated with an incredible maze of nerve cells and grey cells.

also opined about the direct nexus between speech disorder and defective cerebrum, some years earlier. However, Broca turned that thought into a concrete reality by his landmark research.

Later on, to measure the skulls or the craniums of primate apes (chimpanzees, baboons, gibbons, gorillas, orang-utans, monkey, macaques, rhesus monkeys etc), primitive humans and modern-day people in a comparative manner, Broca invented more than 20 apparatuses. In this way, he pioneered the science of measuring the human skull—"Craniology". The instruments that he invented are called "Craniometers".

While measuring the skulls of the human fossils, Pierre Paul Broca revealed the immaculate comparisons among the skulls of the Old Stone Age people (Paleolithic) and New Stone Age (Neolithic) people. He convinced scientists that the gradual increase of space within human skulls aided the increase of the brain's size, thus enabling him to find more avenues to chisel blunt stones to make sharp weapons and tools and to spark the first fire by striking flintstones. He brought out his theses papers on the nexus between anatomical features of the developing brain of humans and gradual genesis of our intelligence and wit.

Broca's spectacular research in the root of our conception in languages and the evolution of our brain influenced a galaxy of luminaries. Among them was the renowned Spanish painter Francesco Goya, whose masterpiece oil painting "Colossus" created ripples in the world of art. In order to assist Broca's brain quest, Goya ordered his skull not be buried in the grave with his dead body.

Along with another neuroscientist, Dr Carl Wernicke (1848-1905), Broca conducted further researches on the language conception area of our brain. However, Broca had to fight off severe criticisms by the then orthodox, religious authorities, especially from the Pope who declared the anatomical quest of Broca a blasphemous one and contradictory to the Christian faith.

Being inspired by the pathbreaking researches of Broca, contemporary neurologists like John Hughlings found out that the frontal lobes and the thalamus of our brain also have the capabilities to comprehend and utter words and languages. The powers of comprehending languages and to deliver speeches are now found to be particularly located in the frontal lobe of the human brain – the Central Sulcus or Fissure of Rolando and Lateral Sulcus or Sylvian Fissure. The front part of the brain's Parietal Lobe, along the Fissure of Rolando, may be linked with our speech and sense of hearing at a deeper state.

The area of our brain in front of the Fissure of Rolando is principally involved in motor functioning, thus relevant to the study of speaking and the upper back part of our brain's temporal lobe, which extends towards parietal lobe, is labelled as "Werhicke's Area". It plays a cardinal role in making us understand other's speeches. We need to understand languages through hearing, or by our auditory reception. This power of comprehension is supplied by the upper part of our brain's temporal lobe. This part is named as "Heasechi's gyri" after the Austrian pathologist R.L. Heschi.

The unique, neurological achievement of Pierre Paul Broca was immortalized in the magnum opuses by Stephen Jay Gould *The Mismeasure of Man* (1981) and in *Broca's Brain* (1986) by the late astronomer, Carl Sagan.

Apart from being a neuroscientist, Pierre Paul Broca also researched on the study of cartilage and bone and pathology of cancer. As a neuroanatomist, he wrote theses on limbic system and rhinencephalon.

Broca had a philanthropic bent of mind also. He supported female education and in this respect strongly campaigned against the famous Christian cleric Felix Antoine-Philbert Dupanloup, Roman Catholic Bishop of Orleans, who thought female education a "stigma on religiosity". Like Socrates, Broca was also denounced by the orthodox community as a "corruptor of youth". However, Broca remained vocal to uphold logic and reason for public welfare.

He also helped the then French Government to upgrade health and hygiene. Until his demise in 1880, Broca remained committed to his medical quest. His two sons also excelled as professors in medical science. Till his last breath, Pierre Paul Broca opposed the excesses of casteism, prejudices and black magic rituals. He strongly announced: "I would rather be a transformed ape than a degenerated son of Adam."

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Care For Your Eyes... Naturally

NAMRTA CHOUDHRY, M.B. SIDDIQUI & SHAZIA

OUR eyes are our windows to the world. This more than sums up the importance of eyes. Eyes provide us sight, without which life would lose most of its meaning. But how well are you caring for these wonderful gifts? The summer and rainy season bring with them a plethora of eye-related problems. But you need not spend huge sums of money for every eye ailment. There are several herbal remedies that can take care of your eye ailments naturally.

Eye care is especially important for everyone in summer because there is a larger amount of light rays in the sunshine. During summer days, people go out for vacations. Some would choose to spend an entire day on the beach. All these outdoor activities involve much sunlight exposure. So, the eyes need extra protection against UV rays. You need to check up your eye health before undertaking outdoor entertainments in summer.

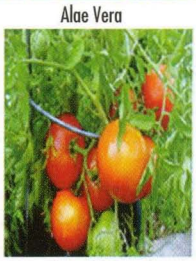
The first thing to do during summer days is to make a lifestyle check. Summer and winter are quite different in that even daily diet should be changed. Some beneficial foods during summers include green leafy vegetables, carrots, liver, cod liver oil, nuts and so forth. The reason is that potential harm from sunrays is higher. Eye exams during summer days are even more necessary than in other seasons.

Ricinus communis

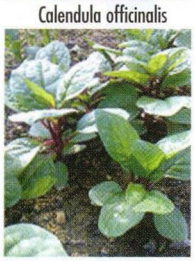
Aloe Vera

Calendula officinalis

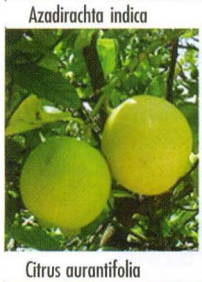
Azadirachta indica



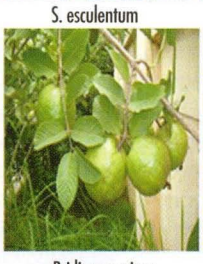
S. esculentum



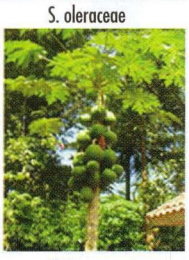
S. oleraceae



Citrus aurantifolia



Psidium guajava



Carica papaya

E. officinalis

Persea americana

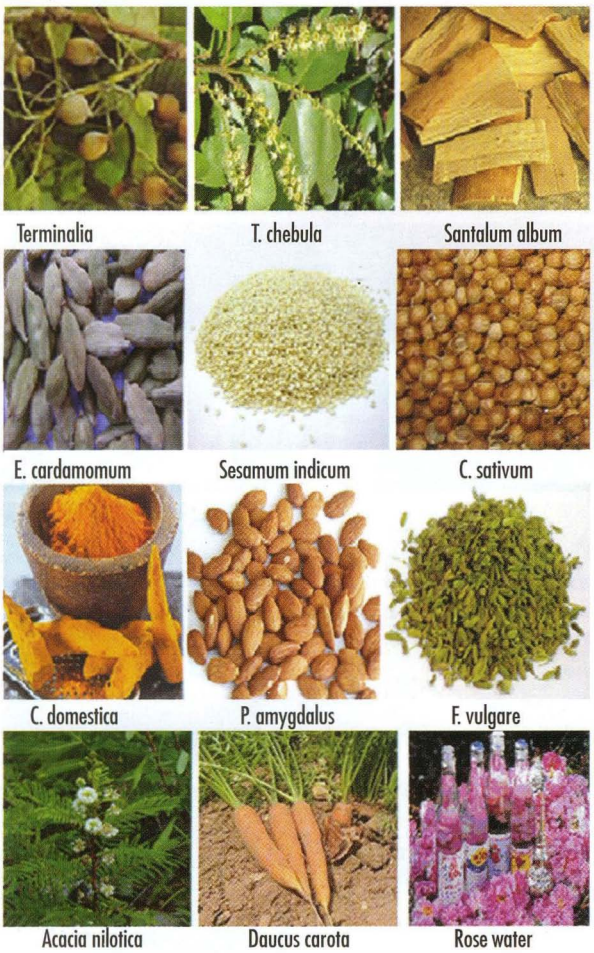
C. auriculata

Eye Stye is a small boil on the eyelid. It may look quite alarming if the eye closes up.

There are several common eye ailments that plague people during summers. Here are some of them and how you can combat these ailments with the help of easily available herbal treatments.

Conjunctivitis: Inflammation of the conjunctiva, the mucous membrane covering the eyeball and lining the eyelids.

- Drink lots of water and fresh vegetable juices. The most beneficial vegetables are Spinach and Carrot. Mix 200 ml of fresh spinach juice and 300 ml of fresh carrot juice daily to help relieve the symptoms of pink eye.
- Mix 1 cup of Gooseberry juice and 2 teaspoon of honey and drink twice a day. Honey is a common ingredient in many herbal remedies, as it helps to purify the blood and kills germs and bacteria that cause or aggravate conjunctivitis.
- Wash the affected eye with Coriander tea. Boil two cups of water and remove from heat. Add one cup of dried coriander and allow steeping for five minutes. Strain the herbs from the liquid and allow cooling to room temperature. Use this herbal eye wash three times a day to relieve pain and soothe the inflammation.
- Babul (*Acacia arabica*) can also treat conjunctivitis. A paste of the babul leaves must be applied on the eyes before going to sleep at night. It will lessen the itchiness, wateriness and the redness of the sore eyes and relieve pain and soothe the inflammation.
- Calendula (*Calendula officinalis*) is taken as a cold infusion for washing eyes that are stressed. This brings a cooling effect to the eyes.
- Neem juice obtained by rubbing a few neem leaves with a little water and strained through a clean piece of cloth is useful for pain in the eyes caused by



conjunctivitis. It is warmed, and a few drops put into the ear opposite the ailing eye to give relief. The eyes are cured after a few applications.

■ Triphala lotion is generally prescribed in case of eye problems. Triphala is a mixture of the two myroblans – belleric (*Terminalia bellerica*) and chebula (*Terminalia chebula*) – and the Indian gooseberry (*Emblica officinalis*). The *chooran* is soaked in water for half an hour to get the lotion. This lotion is used as an eye-wash three or four times in a day. Triphala lotion has potency to treat eye problems such as cataract and conjunctivitis. Washing the eyes regularly with triphala also keeps them moist and healthy.

Eye stye: Stye is a small boil on the eyelid. It may look quite alarming if the eye closes up. A stye is a common infection of the hair follicle of an eyelash, resembling a sore similar to a boil or a pimple in the gland at the edge of the eyelid which leads to blockage of the hair follicles that may become swollen, causing nuisance and may also be painful on touching.

Almonds, fennel and sugar candy are taken in equal amounts and a paste is made out of it. with warm milk during bedtime for keeping away eye ailments.

■ Boil 1 teaspoon of coriander seeds (*Coriandrum sativum*) with a cupful of water like an herbal tea preparation to wash the eyes 3-4 times a day.

■ Boil a handful of Acacia leaves (*Acacia nilotica*) in two cups of water. Make a decoction and use as a compress on the eyelids. It reduces swelling and pain and helps to get rid of a stye.

■ 1 teaspoon of turmeric in 2 cups of water until it reduces to half. Cool and strain 4-5 times through a fine muslin. Apply as eye drops 3-4 times a day.

■ Guava leaves (*Psidium guajava*) warmed and placed on a warm damp cloth, and then used as a compress, reduces the redness, pain and swelling.

■ Slit an Aloe leaf (*Aleo vera*) lengthwise and place the pulpy side on the sore eye.

Improving Vision Naturally

There are several other commonly known fruits, vegetables and herbs that could take of your eye health. Here are some:

■ Avocado (*Persea americana*): The part of the plant used is the fruit which is rich in Vitamin A, B1, and C. Avocado is good for overcoming dry eyes and optical nerve disablement. You can take out avocado juice or eat the fruit as you like.

■ Betel leaf (*Chavica auriculata*): The leaf is good for eye inflammation and headache due to eyestrain. Boil some betel leaves together with 3 glasses of water for 20 minutes or until the water becomes 1 glass. Drink it after the water becomes warm or cold.

■ Lime (*Citrus aurantifolia*): Lime is rich in Vitamin B1 and C that are good for blurry eyes and eyestrain headache. You can take limejuice.

■ Papaya (*Carica papaya*): Papaya is rich in Vitamin A, Vitamin C, and beta-carotene. Papaya fruit is effective in curing myopia or farsightedness and eyestrain headache. Just take papaya juice.

■ Tomato (*Solanum lycopersicum*): Tomato is rich in Vitamin A, B1, and C all of which are good for myopia or farsightedness, nearsightedness, and astigmatism.

■ Carrot (*Daucus carota*): Carrot is rich in Vitamin A, B1, and C which are good for myopia or farsightedness, nearsightedness, and astigmatism. The root is also able to cure poor night vision and eye inflammation.

■ Sesame oil (*Sesamum indicum*): Sesame is rich in Vitamin A, B, and C which are good for eye strain headache, blurry eyes, and poor night vision. You can drink 2 spoons of sesame oil daily or mix together with your juice.

■ Almonds (*Prunus amygdalus*): Immerse almonds in milk and keep them overnight. In the morning, mix this milk with sandalwood. Apply this on the eyelids. This reduces redness of the eyes due to exertion.

■ Cardamom (*Elettaria cardamomum*): Take two small pieces of cardamom, grind them and dissolve the powder in milk. Boil the milk and drink it at night. This makes the eyes healthier.

■ Amla contains lots of vitamin C and hence is good for the eyes.

■ Usage of rose water and limejuice in equal amount, as an eye drop is a very effective method of regaining eye strength.

■ Consumption of walnut daily is also said to improve eyesight.

■ Rose water mixed with potash alum in one seventh of its quantity put in eyes (two to three drops) is very effective in treating eye ailments.

■ Almonds, fennel and sugar candy are taken in equal amounts and a paste is made out of it. Two tablespoonful of this paste is consumed with warm milk during bedtime for keeping away eye ailments.

■ Consuming mangoes is also good for the eyes as it is a rich source of vitamin A and calcium.

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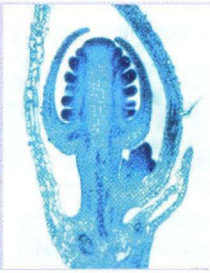
PLANT MORPHOLOGY QUIZ

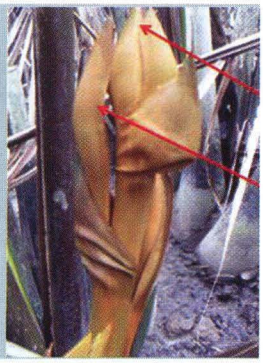
DR. A.K. MONDAL & DR. SANJUKTA MONDAL (PARUI)

1. Flower in which the sepals, petals and stamens (androecium) are attached below the ovary (gynoecium) are:
a. Hypogynous
b. Perigynous
c. Epigynous
d. None of the above



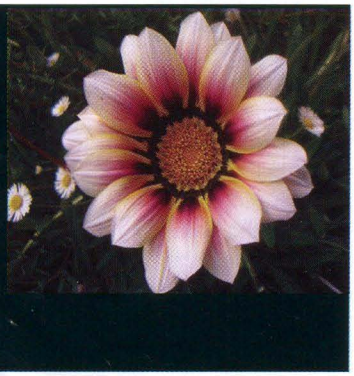
2. Flower that lacks one of the four sets of structures (calyx, corolla, androecium, gynoecium) is:
a. Imperfect
b. Incomplete
c. Complete
d. None of the above

3. If unisexual male and female flowers both occur on the same plant the species is called
a. Monoecious
b. Dioecious
c. Homoecious
d. Heteroecious

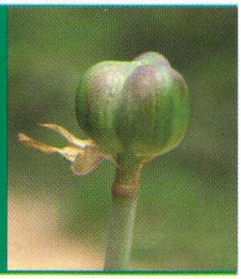


4. If anthers shed their pollen before the stigma is receptive in the same flower it is:
a. Protogynous
b. Protandrous
c. Protoandrogynous
d. None of the above

5. Primitive flower types:
a. Are incomplete
b. Have many petals, stamens or pistils
c. Are symmetrical
d. None of the above



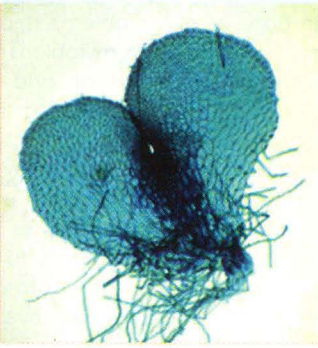
6. Advanced flower types have:
a. Superior ovaries
b. Separate petals
c. Inferior ovaries
d. None of the above



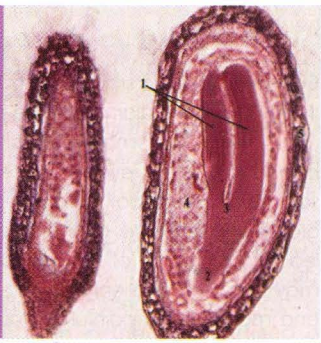
7. A dry single seeded fruit in which the pericarp has grown out to form a wing is:
a. Achene
b. Nut
c. Samara
d. None of the above

8. A fruit made up of several ovaries from a single flower is a
a. Multiple fruit
b. Aggregate fruit
c. Compound fruit
d. None of the above

9. What is missing from the (angiosperm) mega-gametophyte, which was present in the pine?
a. Archegonia
b. Antheridia
c. Archegoniophore
d. Antheridiophore

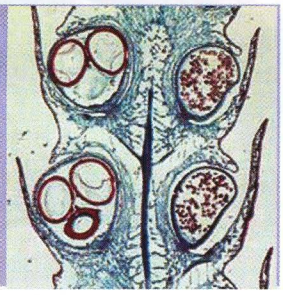


10. What are the food storage tissues in these seeds?
a. Endosperm
b. Cotyledon(s)
c. Hypocotyls
d. Endosperm and cotyledon(s)

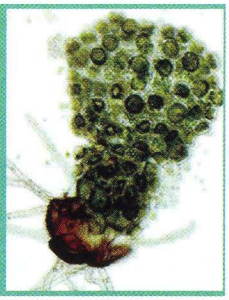


11. What stage in the life cycle does a flowering plant represent?
a. Gametophyte
b. Sporophyte
c. Strobilus
d. None of the above

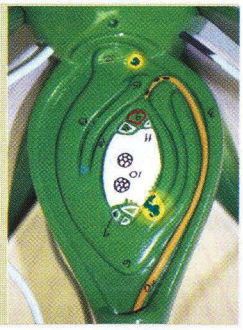
12. Are flowering plants:
a. Homosporous
b. Heterosporous
c. Non-spore forming
d. None of the above



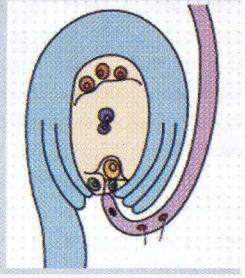
13. Does the male gametophyte develop
a. Free swimming sperm
b. Many cells
c. Three cells
d. None of the above



14. The eight cells typically formed in the ovule represent:
a. Megaspores
b. An archegonium
c. Female gametophyte
d. None of the above

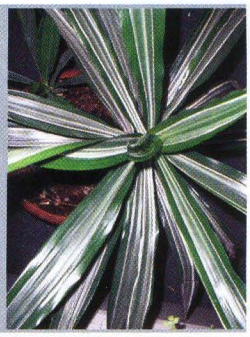


15. The sperm nuclei travel down the pollen tube to fuse with:
a. The egg
b. The egg and the synergids
c. The egg and the central cell
d. None of the above

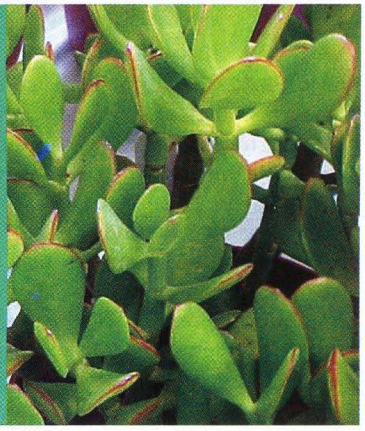


16. The ploidy level of the endosperm is:
a. 3n
b. 2n
c. 1n
d. None of the above

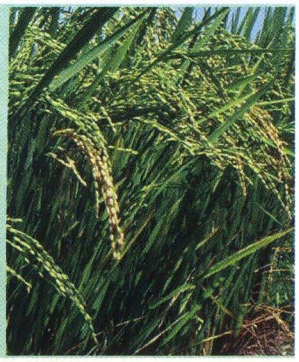
17. A plant with a net-like pattern of veins on its leaves is likely to be:
a. A monocot
b. A dicot
c. None of the above



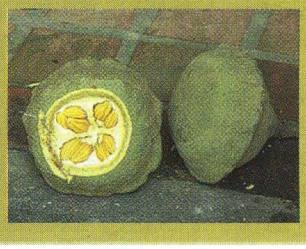
18. A plant whose flowers have many petals, stamens or pistils is likely to be a:
a. Monocot
b. Dicot
c. None of the above



19. A plant whose flowers have three petals, stamens or pistils is likely to be a:
a. Monocot
b. Dicot
c. None of the above



20. What is the critical difference between angiosperms and gymnosperms?
a. Seed is enclosed in sporophylls that form one or more carpels of the ovary
b. Seed is on the surface of the sporophyll
c. None of the above



ANSWERS:

1. a, 2. a, 3. a, 4. b, 5. c, 6. c, 7. c, 8. b, 9. a, 10. d, 11. b, 12. b, 13. c, 14. c, 15. c, 16. a, 17. a, 18. b, 19. a, 20. a

Contributed by Dr. A. K. Mondal, Associate Professor and Head of the Department, Plant Taxonomy, Biosystematics and Molecular Taxonomy Laboratory, Department of Botany & Forestry, Vidyasagar University, Midnapore-721 102, West Bengal; Email: amalcaebotvu@gmail.com
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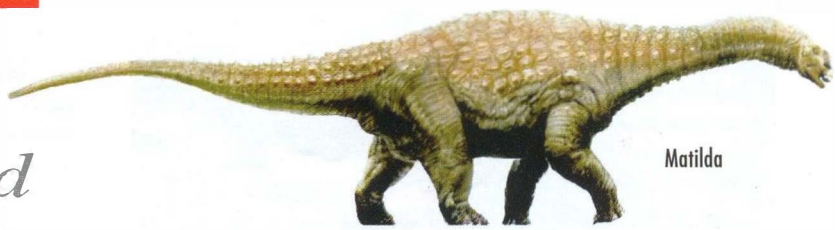
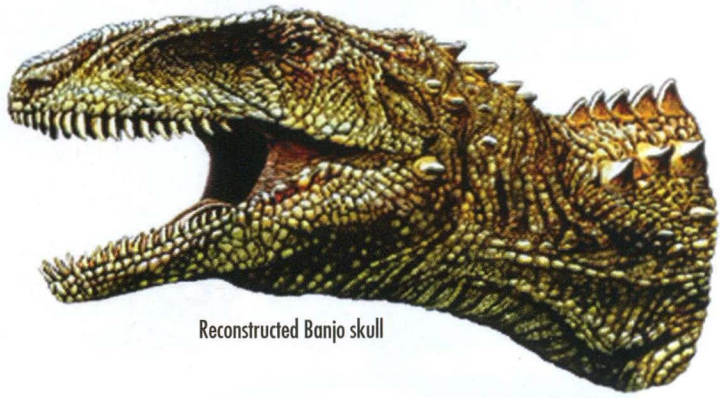
Dinosaur Duo: *Banjo and Matilda*





Banjo is *Australovenator wintonensis*, a small meat-eating dinosaur called a theropod. Matilda is *Diamantinasaurus matildae*, a small herbivorous dinosaur called a sauropod. You would not really expect them to be a couple, and in life, they weren't. But this unlikely couple, or rather their remains, were fished out of an Australian billabong (oxbow lake) 98-100 million years ago after they breathed their last. The Australian Age of Dinosaurs Museum of Natural History and Queensland Museum worked together on this project. Queensland Museum's geoscientists Dr Scott Hocknull and Dr Alex Cook were involved in the discoveries.

Australovenator comes from the Latin words '*Austral*' meaning from the south, '*venator*' meaning hunter. So Banjo is 'Southern hunter of Winton.'

Matilda got her name from the word Diamantina, which refers to the Diamantina River that runs close to the place where she was excavated. The word '*sauros*' is Greek for lizard. Her nickname Matilda, pays homage to "Waltzing Matilda" which is one of Australia's National songs. The wealth of meaning in the names Banjo and *Australovenator wintonensis* become clearer when it is known that Waltzing Matilda was written by Banjo Patterson in 1895. Patterson not only wrote the song when he was in Winton, a town in Queensland, Australia but the *Diamantinasaurus* fossil has been found here too.

The Winton Formation is a rich hunting ground for dinosaur fossils. It is the site of a spectacular dinosaur stampede called Winton Trackway. At least 160 individual dinosaurs left 3000 footprints here for posterity.

Banjo: Banjo's story goes back about thirty years when a dinosaur bone was discovered in 1981. It was thought to be the anklebone of a Jurassic theropod called *Allosaurus.* Now, after three decades it is being stated that it belongs to the *Australovenator* called Banjo. Its nearest relatives were the Japanese *Fukiraptor* and *Neovenator* from England.

Banjo is the most complete meat-eating dinosaur skeleton found as yet, in all of Australia although not all parts of the skeleton have been found. What has been found includes, nine serrated teeth, left lower jaw, some ribs, parts of hind legs and some fingers and toes. Banjo is about 5 metres long, standing 1.5 metres tall at the hip and in life would have weighed about 500 kg. "The cheetah of his time, Banjo was light and agile," says Scott Hocknull who laid the *Allosaurus/Australovenator* controversy to rest. "He could run down most prey with ease over open ground. His most distinguishing feature was three large slashing claws on each hand. Unlike some theropods that have small arms (think *T. rex*), Banjo was different; his arms were a primary weapon....He's Australia's answer to Velociraptor, but many times bigger and more terrifying."

MATILDA GOT HER NAME FROM THE WORD DIAMANTINA, WHICH REFERS TO THE DIAMANTINA RIVER THAT RUNS CLOSE TO THE PLACE WHERE SHE WAS EXCAVATED. BANJO IS 'SOUTHERN HUNTER OF WINTON.'

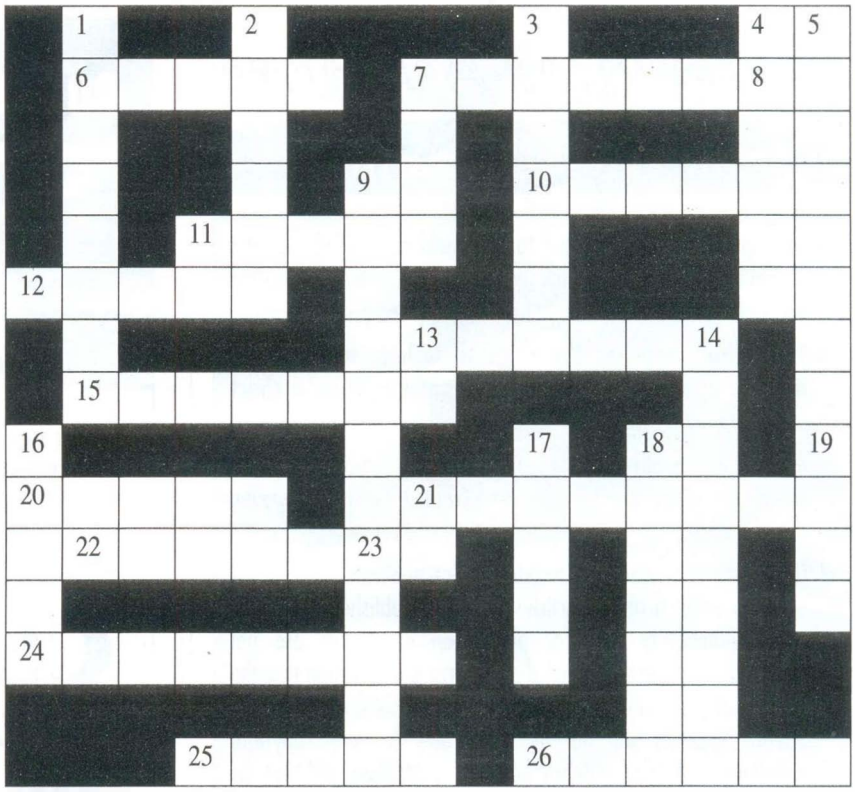
Matilda: Matilda, on the other hand, represents a terrestrial, solid and robust animal that was most likely a hippo-like species. It was a titanosaur; one of the largest animals ever to walk on Earth. These were a group of sauropods common to the now-discontinuous regions that were once part of Gondwana or the massive mother continent. Matilda is about 15 m long and stands about 2.5 m tall at the hip. In a model reconstructed from the partial remains that have been excavated, Matilda is shown to have bony osteoderms in the skin. However, no osteoderms have yet been recovered from the site.

It is speculated that Banjo and Matilda may have been predator and prey...and that Banjo came to a sticky end when he jumped into the billabong to attack Matilda. As Hocknell put it, "It's phenomenal to find two dinosaurs in the same site. There's a bit of a mystery around why they were both there. Maybe they both drowned or perhaps the herbivore was stuck in the mud and it attracted the predator to its death." It is obvious; Banjo did not know that he had to look before he leapt.

Dr Sukanya Datta, Scientist NISCAIR posted to Director General's Technical Cell, CSIR HQ, Email: sukanya@csir.res.in

ACROSS

6. Fluid containing sperm and various secretions that are ejaculated by male animals during copulation (5)
7. Animal embryo at the early stage of development when it changes from the morula to a hollow ball of cells (8)
10. Abnormal outgrowth on a plant that develops due to attack by insects (4)
11. A wire designed to melt when excessive current passes through (4)
12. A triangular block of transparent material used to split a beam into its spectral colours (5)
13. Offspring from a cross between individuals of two different species (6)
15. Method of animal reproduction where eggs are laid by female and develop outside her body (7)
20. A preliminary test for AIDS (5)
21. The change in the apparent position of an object when viewed from two different positions (8)
22. A group of enzyme that breaks down starches into their component molecules (7)
24. The curved upper surface of a liquid in a tube (8)
25. Outer coat of a seed, formed after fertilization of ovule (5)
26. Covering of the lungs (6)



DOWN

1. Two chemical compounds having same molecular formula but different arrangement of atoms in their molecules (7)
2. Lowest part of large intestine that stores faeces prior to elimination (6)
3. A part of an ore deposit that is not itself economically valuable (6)
4. A viral disease (3)
5. Solid cluster of nervous tissue (8)
7. Thick rounded underground stem of plants like onion (4)
8. Related to moon (5)
9. Microscopic unit in vertebrate kidneys that forms urine (7)
14. Technique for removing waste products from the blood during kidney failure (8)
16. Clear fluid that separates out from clotted blood (5)
17. Device used to slow down or stop the movement of a moving body (5)
18. Part of a seed embryo that develops into the shoot of a plant (7)
19. Upper angle between a leaf and the stem from which it grows (4)
23. A conductor of very low resistance that is connected in parallel to an ammeter to enable it to measure larger current (5)

Contributed by Ms Prabhdeep Kaur, D/o Paramjit Singh, H.No. 514 A, VV Reddy Complex, 4th Cross, Ashwath Nagar, Bangalore-560094

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